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ABSTRACT

This guide is intended to assist vocational teachers who are teaching a course in industrial machinery maintenance and repair; electromechanical, hydraulic, and pneumatic instrument repair; or building maintenance. Addressed in the individual units of the course outline are the following topics: assembling and disassembling machine mechanisms; installing and removing machinery; maintaining and repairing hydraulic systems, heating/cooling devices, boilers, and tractors and trucks; inspecting and repairing cranes and elevators; performing electrical, carpentry, welding, drill press, grinding, milling, turning, and shaping and cutting operations; working metal with hand or power tools; inspecting and troubleshooting equipment; and supervising maintenance and repair functions. Each unit is divided into subsections covering one specific duty. Each of these subsections contains some or all of the following: a duty statement, performance objective, task statement, task conditions, standard and source for the standard, performance guidelines, enabling objectives, learning activities, resources, evaluation questions, and answers. Appendixes include lists of duties and tasks, tools and equipment, and sources of standards; definitions of terms; 14 references and a 44-item bibliography of state-of-the-art literature; and information sheets on counterboring, countersinking, spot-facing, drilling, reaming, honing, tapping, and changing coolants. (MN)

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V-TECS GUIDE

FOR

INDUSTRIAL MAINTENANCE MECHANIC

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PREFACE

This guide was developed to encompass the three areas of Industrial Machinery Maintenance and Repair (47.0303), Electromechanical, Hydraulic, and Pneumatic Instrument Repair (47.0401) and Building Maintenance (46.0401). Instructors are encouraged to use the portions of the guide as appropriate for their local program as recommended by their industry advisory committees. Industrial Maintenance is so comprehensive it was felt that a guide needed to be developed to provide instructors with various options. Many smaller industries require maintenance personnel to have a variety of general skills while larger industries might require more specific technical skills. This guide will give both options to local school districts to meet local needs in both machine and facility maintenance.

ACKNOWLEDGMENTS

The Industrial Maintenance Mechanic V-TECS Guide was developed from the Industrial Maintenance Mechanic V-TECS Catalog by a committee of Industrial Maintenance instructors in South Carolina. These instructors are to be commended for their expertise in the field and for their ability to complete the tedious work required in developing this V-TECS Guide. The writers are:

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Upon completion of the writing of Industrial Maintenance Mechanic V-TECS guide, six educators were selected to field review the material for validity and reliability. These educators are to be commended for their thoroughness in providing their expertise in modifying and approving this guide for classroom use. The field reviewers are:

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INTRODUCTION

V-TECS guides are an extension or continuation of the V-TECS catalogs. While the V-TECS catalog is a composition of duties, tasks, performance objectives, and performance guides, it deals only with the psychomotor aspect of an occupation. It is a blueprint of an occupation. It deals only with the identification of the "hands on" aspect of the occupation. It does not take into consideration such things as the background information surrounding a task, how to make inferences, generalizations and decisions from a body of knowledge, nor does it deal with attitudes, job seeking skills, safety or energy conservation practices. V-TECS guides take these aspects of teaching and learning into consideration.

Experience has shown that the art of learning can also be taught while teaching subject matter. People need to learn how to learn. V-TECS guides take into consideration how students learn and are an efficient way for instructors to assist them to learn.

V-TECS guides are centered around all three domains of learning: psychomotor, cognitive, and affective. The following is a brief explanation of each.

Psychomotor

Any manipulative skill such as tightening a nut, replacing a hubcap, sharpening a pencil, machining a key slot in a steel shaft, or replacing a SCR in a solid state control panel are examples of manipulative or psychomotor skills. Tasks such as these are identified in V-TECS catalogs. V-TECS catalogs also group tasks by duties and objectives. Each performance objective has a performance standard which must be met to prove student proficiency in the manipulative aspect of the task. The V-TECS catalog, however, does not include any suggestions as to how to learn to do these tasks.

V-TECS guides are developed around psychomotor tasks which are worker oriented.

Cognitive

To perform psychomotor tasks, students must think. To tighten a nut they must know which way to turn it and when to stop turning it so that they won't strip the threads or shear the bolt off. If replacing a hubcap, there is a certain technique that may vary from one car to another. For example, start the hubcap by placing the cap in a tilted position and tapping it all the way around until it is properly seated. On a different model, it may be necessary to position the hubcap and snap it all at once. At any rate, students must think about what is being done. This is cognition or a mental activity. Cognition is what goes on in the mind about any job being done. V-TECS guides provide both the collateral knowledge and the impetus to apply cognition to psychomotor tasks.

Students gain cognition through both real and vicarious experiences. They may read, view tapes, memorize or practice a process or procedure until they are certain of it. To test their knowledge, students may be required to decide the proper procedure, method of sequence for performance. This decision making process or cognitive activity provides the basis for higher thinking skills.

Cognition, then, is that process by which information is stored and used. That voice that warns one of potential dangers is cognition. Anything that goes on in the mind is cognition. Students may become the best workers in their job; but if they fail to think a process through and apply their experience, they may become just one more statistic. It is cognition that tells them to lock and tag out the power supply to an electrical apparatus before starting to repair it. However, cognition does not apply only to safety. Good cognition or thinking can help employees do a job better and quicker. V-TECS guides provide for the cognitive aspects of learning.

Affective

Curriculum writers, supervisors, and instructors often fail to assist students in acquiring a positive attitude toward themselves, their jobs, their school, or their fellow students. V-TECS guides seek to provide assistance to the instructor in achieving this. It is difficult for the instructor to identify little bits and pieces of desirable behavior for every unit and often harder yet to teach them. In this area, students might be judged as to how well they clean up their work area, whether they show up to do the job on time, or whether they must be told several times to do something. Potential employers are interested in student attitude because persons angry at themselves or uncertain of themselves are often poor workers.

A student's ability to succeed on the first job and every job thereafter depends largely on attitude. If, for example, students have the attitude of "let someone else do it," they could be in trouble. Students using V-TECS guides will have activities dealing with how to get along with other students, supervisors, or staff members both in large and small groups.

USE OF V-TECS GUIDE

The guide is designed to provide job-relevant tasks, performance objectives, performance guides, resources, learning activities, evaluation standards and achievement testing in selected occupations.

A V-TECS guide is designed to be used with any teaching methods you may choose. If a lecture/demonstration method is best for you, you will find sufficient help to meet your needs. If you prefer to use discussions or other methods that require student participation, you will find ample help. Regardless of which method is successful for you, a V-TECS guide can save preparation time and offer innovative methods and procedures. For example, students may work either alone or in teams while in class and learn skills in direct relation to what is actually done on the job. This work also takes into consideration student attitudes, thinking skills, and mathematical reading skills.

The use of small groups in teaching can be helpful in two ways: (1) many students may feel inadequate due to their lack of background information in mechanical things; and (2) some students may feel that they are physically incompetent or lack the necessary background experiences. A successful program (course) can provide students with a sense of security by reinforcing positive attitudes while improving skill and knowledge of the subject. By allowing students to interact on a personal level, this task/learner-centered approach can achieve this. As students gain confidence and discover that they are an essential part of a team engaged in the learning-teaching process, their confidence increases. Too, the student in this setting can learn to work without direct supervision. In addition, use of the small-group method permits the instructor to vary instructional routines away from lecture or other full-class methods to activities for single students, pairs of students or any number so desired.

You will find suggestions for specific classroom activities. The activities are not meant to restrict you or your students, but only to suggest a variety of learning activities for each task statement. Please do not feel that you must take your student through all the activities.

ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 01

TASK: Align and tension a belt drive.

CONDITIONS: A new or existing drive, involving a driver (motor, engine, or line shaft), a driven machine, and the following tools and equipment:

Dial indicator
Feeler bar or measuring stick
Level set
Mechanic's tool box (hand tools)
Personal safety equipment
Straightedge or wire
Switch lock out
Tension meter.

STANDARD: When completed, a flat belt will track center of pulley rims without jumping off. A V-belt will not turn over in groove or jump out. Tension will deliver full and uniform power without slippage and tension meter will register according to manufacturer's specifications. Top of V-belt should not be more than 1/16 inch below rim of pulley.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen, **Developing Troubleshooting Skills**, pp. 97-112.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 1022-1027, 1035-1051

PERFORMANCE GUIDE

1. Lock out machine power.
2. Check pulleys and belts for wear and damage. Replace if necessary. If a new installation, slide on shaft into approximate position and tighten moderately until after alignment.
3. Check and adjust shafts to same plane at correct design angle with level, straightedge and measuring tape.
4. Loosen motor.
5. Set shafts parallel with tape, feeler bar or dial indicator. Tighten motor and machine hold-down bolts.
6. Loosen and align pulleys by a straightedge across their faces, or by tight wire or string across the faces or grooves. Fasten pulleys firmly.
7. Install belt(s) by sliding driver (motor or engine) to decrease shaft center distance. Belts must go into position easily.
8. Check that each belt is equally slack on the top side, if a set of belts is installed.
9. Slide the motor back to give about the right tension and tighten hold-down bolts.

Performance Guide Continued

10. Check belt tension.
    a. For fractional horsepower and standard-multiple V-belts, do this by "feel." Strike the belt with the side of the hand below the little finger. Proper tension gives a live and springy feeling. Too loose will feel slack and dead. Too tight will feel like striking a board.
    b. The more accurate tension check required for the high strength and low stretch belts is made with a tension meter. The sensing element is pushed into the back side of the belt, to depress it a given distance. Use according to meter manufacturer's directions. Tension the belt to the value specified by the belt maker for this particular drive.
    c. Belt tension can also be measured by percent stretch, if the belt manufacturer agrees (that there is adequate stretch needed to obtain the desired tension). With the top run slightly snug (barely straight), lay out the maximum available distance, marking each end on the belt. Transfer each mark to adjacent and secure structure. Tension the belt until the percent movement (half at each end) is shown between the belt marks and the stationary marks. Only a stretch figure from the belt maker should be used.
11. Unlock/"jog" the unit to properly seat or position the belt(s). Belts should not "jump off" pulleys.
12. Shut down the unit.
13. Adjust belt tension:
    a. Adjust controllable idler to design tension by turning take-up screw.
    b. Adjust shaft center distance by sliding motor to design tension by loosening and tightening hold-down bolts.
14. Make final checks on shaft and pulley alignment. Tighten all pulley fastenings and equipment hold-down bolts, using a torque wrench for larger bolts.
15. Start the machine to observe alignment and delivery of power.
16. Shut down. Put belt guards in place. Check lubrication of drive.
17. Operate drive for 24 to 48 hours.
18. Shut down and recheck belt tension.

ENABLING OBJECTIVES

Use of measuring tools.
Use of hand tools.
Use of straight edge to align pulleys.
Use of tension meter.
Use of safety.
Knowledge of belt drives.

PERFORMANCE OBJECTIVE V-TECS 01

LEARNING ACTIVITIES

1. Demonstrate how to install lockout on power supply.
2. Identify the type of pulleys and belts.
3. Explain the proper procedure for tensioning belts and pulley alignment.
4. Explain the proper procedures to align two parallel shafts.
5. Show how to check all components for wear or damage, identify those in need of repair or replacement.
6. List the steps in reinstalling all safety devices.
7. Evaluate the student's performance when completed using the objective questions.

RESOURCES

Manufacturer's Manual and Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide,** pp. 88-91

EVALUATION

Questions

1. Belt drives transmit:
   a. Horse power
   b. Energy
   c. Rotary Motion
   d. All of Above.
2. Which of the following statements is most correct?
   a. Proper tension of belts will cause slippage.
   b. On Multi Belt Drives you must use matched belts.
   c. V-belts provide a positive drive.
3. Which of the following are critical factors for belt drives?
   a. Tension
   b. Cleanliness
   c. Condition of pulley grooves
   d. All of above.

Answers

1. d
2. b
3. d

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 02

TASK: Maintain belt drives.

CONDITIONS: A malfunctioning belt drive, spare parts, and the following supplies, tools and equipment:

Feeler bar
Level set
Machine tool box (hand tools)
Personal safety equipment
Set of V-belt sheave groove templates
Straightedge or wire
Switch lock out
Tension meter
Thermometer (Fahrenheit).

STANDARD: When completed, the drive will deliver rated power smoothly and at rated speed. The belt drive will be free of uneven wear, squealing, high temperatures, loose bolts, flapping of belts, flying dirt, oil, steam, water, rubbing of guards and unscheduled shutdowns. Operating temperature will not exceed 180°F.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen, **Developing Troubleshooting Skills**, p. 109.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 1028-1029, 1050.

PERFORMANCE GUIDE

1. Run mechanism at normal rate and load.
2. Check for flying dirt, oil, grease, water and other debris.
3. Check for flapping, oscillating, slipping belts.
4. Check for squealing, binding and rubbing of parts.
5. Apply belt dressing (flat belts only).
6. Lock out mechanism power.
7. Check belts and pulleys for uneven wear and damage, and replace if necessary.
8. Check for loose mounting bolts and loose guards.
9. Check for hot belt, bearings and pulleys.
   a. Consult manual regarding expected temperature rise over room temperature.
   b. Compare with other bearings, pulleys and belts.
10. Check pulley alignment.
11. Check belt tension.
12. Disassemble, clean, inspect for wear and damage, repair/replace and reassemble drive as necessary.

PERFORMANCE OBJECTIVE V-TECS 02

PERFORMANCE GUIDE Continued

13. Unlock/start mechanism and test.
14. Keep record of maintenance/servicing.

ENABLING OBJECTIVES

Compute fractions.
Use measuring tools.
Calculate proper defection force and distance.
Use hand tools.
Use straight edge to align pulley.
Interpret thermometer readings.
Use sense of sight and hearing to verify proper operation.

LEARNING ACTIVITIES

1. Demonstrate how to install lockout mechanism for power.
2. Identify types of sheaves and drive belts.
3. Explain the proper procedure for tensioning belts and sheave alignment.
4. Identify probable reasons for breakdown by inspecting drive belt.
5. Show how to clean and check all components for wear and alignment before intalling new belts.
6. Explain how to install new belts to proper alignment and tension according to manufacturer's specifications.
7. List the steps in re-installing all safety covers and devices.
8. Explain the need to update maintenance service records to reflect repairs.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 99-102.

EVALUATION

Questions

1. Which of the following belts provide positive drive?
   a. V-Belt
   b. Timing Belt
   c. Flat belts.
2. Belt drives are used to transmit:
   a. Rotary motion
   b. Horsepower
   c. Energy
   d. All of the above.

Evaluation Continued

3. Drives that use multigroove sheaves should have belts that:
    - a. Have the same stock number
    - b. Have the same match number
    - c. Have the same type tension member.
4. Which of the following are critical factors for belt drives?
    - a. Tension
    - b. Sheave alignment
    - c. Cleanliness
    - d. All of above.

Answers

1. b
2. d
3. b
4. d

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 03

TASK: Construct belt joints with mechanical fasteners.

CONDITIONS: A belt drive, an adequate stock of flat belting for this drive, and the following supplies, tools and equipment:

Awl leather punch
Belt tension meter
Belting
Blueprint of Equipment
Carpenter's C-clamp
Hard wood or metal surface
Jacking belt clamp
Lacing machine
Leather lacing
Leather worker's knife
Maul
Mechanic's tool box (hand tools)
Mechanical splicing materials
Personal safety equipment
Wire lacing.

STANDARD: When completed, the drive will operate smoothly and the belt will track on pulley crowns without oscillating laterally.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Determine belt length by:
   a. Direct Measurement. Use steel tape and measure over pulley crowns, or
   b. From Blueprint. Calculate from shaft centers' distances and pulley diameters.
   c. Old Belt. Measure old belt. Deduct six-times the belt's thickness to allow for stretch developed in old belt.
3. Construct joint in one of three ways:
   a. Plate-Type Fasteners. Place hook and plate-type fasteners across joint.
      (1) Place hard wood or metal surface under joint.
      (2) Put plate through hooks of each fastener.
      (3) Close hooks of each fastener into belt ends with hammer and back-up maul behind wood or metal surface.
      (4) Remove plate if using jacking belt clamp.
   b. Wire Lacing. Punch holes for wire laced joint with lacing machine and lace with wire according to manufacturer's specifications.

PERFORMANCE OBJECTIVE V-TECS 03

Performance Guide Continued

   c. Leather Lacing. Lay out and punch holes with leather punch or awl and laces with leather.
4. Place belt over pulleys. Clamp one end in jacking belt clamp. Pull other end through other side of clamp until snug. Clamp securely.
5. Pull up belt until two square ends are butted by adjusting the jacking screws.
6. Fasten joint.
   a. Insert plate.
   b. Tighten/adjust wire lacing.
   c. Tighten/adjust leather lacing.
7. Remove jacking clamp.
8. Unlock/start the drive. Run belt slowly and unloaded.
   If belt tracks the crowns of pulleys, bring up to operating speed.
9. Turn off the drive.
10. Adjust for tension.

ENABLING OBJECTIVES

Compute fractions.
Use measuring tools.
Use hand tools.
Use of leather.

LEARNING ACTIVITIES

1. Explain the 3 different methods for determining proper belt length.
2. Explain the 3 ways to construct a belt joint.
3. Demonstrate how to install a lock-out on machine power supply.
4. Explain the proper use of Jacking Belt Clamp.
5. Upon completion of making joint, ask the students to check proper alignment and tension.

RESOURCES

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide,** pp. 132-134.

Manufacturer's Specifications.

PERFORMANCE OBJECTIVE V-TECS 03

EVALUATION

Questions

1. Using the old belt method to determine belt length, which of the following is correct?
    - a. Measure old belt.
    - b. Deduct width of belt to allow for stretch in old belt.
    - c. Stretch old belt out on flat surface when measuring its length.
2. Belt drives are used to transmit:
    - a. Energy
    - b. Horsepower
    - c. Rotary motion
    - d. All of above.
3. Upon completion of constructing Belt Joint, which of the following is incorrect when checking belt out?
    - a. Remove lock-out.
    - b. Run belt slowly and under full load.
    - c. If belt tracks and crowns on pully, bring up to operating speed.

Answers

1. b
2. d
d. b

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 04

TASK: Construct belt joints with adhesives.

CONDITIONS: A belt drive, adequate stock of flat belting, and the following supplies, parts, tools and equipment:

Adhesives
Belt tension meter
Bevelling plane or draw knife
Blue Print
Carpenter's C-clamp
Jacking belt clamp
Leather worker's knife
Manufacturer's specifications
Mechanic's tool box (hand tools)
Personal safety equipment
Wire lacer (if laced joint).

STANDARD: When completed, the drive will operate smoothly and the belt will track on pulley crowns without oscillating laterally.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., p. 1027.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Determine belt length by:
   a. Direct Measurement. Use steel tape and measure over the pulley crowns, or
   b. From Blueprint. Use shaft center distance and the pulley diameters to calculate the length of the belt, either open or crossed, or
   c. Measure the Old Belt. Deduct from this tape line measurement six times the belt's thickness (to allow for stretch developed in the used belt).
3. Add an allowance for laps to the required length. Use a 4 inch lap for belt widths up to 3 inches, and a 6 inch lap for widths greater than 3 inches. For extra heavy or extra light belts, consult the belt manufacturer for lap length.
4. Cut the lap tapers. Use a special plane or draw knife on a level surface. The direction of incline of the lap joint should put the leading edge on the pulley side of the belt, the trailing edge on the outside.
5. Clean the completed lap surfaces. NOTE: With leather belting, be sure that the flesh side is out and the smooth or grain side is next to the pulley.

PERFORMANCE OBJECTIVE V-TECS 04

Performance Guide Continued

6. Position prepared belt: NOTE: Reduce pulley center distance if necessary.
   a. Belts under ten feet. Center over the pulley crowns.
   b. Belts over ten feet. Place over shafts in non-tension state.
7. Clamp one end securely in a jacking belt clamp. Pull the free end through the other side of the clamp until snug, then clamp securely.
8. Coat lap tapers with belt cement, but do not join yet.
9. Pull up the belt ends until check marks indicate that it is at specified length by turning the jacking screws on the belt clamp.
10. Put the cemented surfaces together and apply pressure with C-clamps bearing on board pieces.
11. Remove the lap clamps. Allow the lap to dry undisturbed for a half hour, or as the cement manufacturer specifies.
12. Remove the jacking clamp. Do not put the belt into service for two hours after sticking, unless the cement maker allows otherwise.
13. Unlock/start the drive. Run the belt slowly and unloaded. If it tracks properly and behaves well, bring it up to operating speed and run unloaded for an hour before putting it into service.
14. Stop machine. Recheck tension.

ENABLING OBJECTIVES

Compute fractions.
Use of measuring tools.
Use of hand tools.
Use of leather.

LEARNING ACTIVITIES

1. Show how to install a lock-out on machine power.
2. Identify the types of leather working tools required to cut lap tapers.
3. Explain the proper procedure to determine length of belt to include laps.
4. Explain the step by step procedure used to prepare and construct leather belt joint.
5. Demonstrate how to install new belt to proper tension and alignment according to manufacturer's specifications.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 128-132.

PERFORMANCE OBJECTIVE V-TECS 04

EVALUATION

Questions

1. Which of the following are important in making a good joint on leather belts?
    a. Both tapers are equal.
    b. When tapers are put together belt thickness is uniform.
    c. Both tapers must be clean.
    d. Apply proper amount of cement to both tapers.
    e. All of above.
2. Upon completion of constructing belt joint, when checking belt out, which is incorrect?
    a. Run belt slowly and unloaded.
    b. Remove lock-out.
    c. If it tracks properly, bring it up to operating speed unloaded and run it for one-half hour before putting into service.
    d. Stop machine, recheck tension.

Answers

1. e
2. c

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 05

TASK: Install, align and tension a chain and sprocket drive.

CONDITIONS: A chain and sprocket drive (may vary in size from 1/4" pitch operating a control to a 3" pitch multiple strand delivering 1,000 hp from motor to press), involving a driver (motor, engine, or takeoff shaft) and a driven machine or component thereof, chain, connecting links, offset link, cleaning fluid and the following supplies, parts, tools and equipment:

- Coupling tool
- Drive pins
- Feeler bars
- Jacking screw
- Level set
- Mechanic's tool box (hand tools)
- Personal safety equipment
- Straightedge
- Wire and tightener.

STANDARD: When completed, the drive will operate smoothly without jumping, binding, squealing, rubbing, and will deliver full and uniform power. Chain will not jump off sprockets. Chain sag should be within 1/8" of 2% of the shaft center distance.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 1052-1076.

PERFORMANCE GUIDE

1. Lock out driver (motor or takeoff shaft) power.
2. Inspect sprockets and chain for wear and damage, and replace if necessary.
3. Slide sprockets on respective shafts with side of hubs with set screws and keys accessible for tightening.
4. With sprockets in approximate position, tighten moderately.
5. Adjust shafts to same plane with level and/or tape and straightedge.
6. Set both shafts parallel with feeler bars.
7. Tighten hold-down bolts of motor, machine or bearing housing to maintain shaft positions.
8. Align sprockets by using a straightedge across the machined side surfaces. If the shaft spacing is greater than the length of the available straightedge, a taut spring steel wire may be used.
9. Tighten sprocket fastenings firmly after alignment. Check for movement.
10. Install chain. Clean if dirty. Lubricate pin and bushing surfaces.

Performance Guide Continued

a. Adjusting Shaft-Drive. Move one shaft closer than the normal operating position to the other shaft by loosening hold-down devices.

b. Fixed Shaft Center.

(1) Fit the chain on both sprockets, bringing the free ends together on one sprocket, to hold it while pinning. Insert the pins of the connecting or master link in the two end links of the chain; then install the free plate of the connecting link. Secure the plate with cotter pin or spring clip, whichever fastener is used. See that the outside of the secured free plate is snug against the fastener, by tapping back the ends of the connecting link pins so the spring clip is in the undercuts of the pins. This is to give maximum clearance between the connecting link and the sprocket, both for lubrication and for free flexing of the joint.

(2) If it is difficult to join the chain on a sprocket, or if the chain is large and heavy, a coupling tool can be used. This has two holders or clamps, one on each free end of the chain. With each holder secured, the ends are drawn together by a jacking screw across the holders.

11. Tension the chain.

a. Adjustable Shaft Drive. Position moveable shaft for a chain sag of 2% of the shaft center distance, with the drive not running. The sag to be used may be taken as the nearest even 1/8" value to the exact 2% calculated value. Sag is determined by measuring the drop of the top run of chain below straightedge when the top run is pulled down so the bottom run is taut. The top run is pulled down at a point half-way between the two sprockets. The straightedge is set across the chain over the two sprockets. After measuring the sag, adjust the shaft center distance until the proper sag results. Tighten hold-down devices.

b. Fixed Shaft Centers. Provide for tension as follows: A chain-tightening idler may be used on the slack side of the chain. If the idler is located outside the chain, place it nearer the smaller sprocket (to increase its wrap). An inside idler should be located nearer the larger sprocket. Its adjustment may be made by loosening the mounting bolts, resetting the idler for correct tension, then tightening the bolts. The spring loaded idler uses a coil spring to pull the idler sprocket against the chain. This removes the need for constantly adjusting the idler. Make sure idler has room for adjustment. Shorten chain if necessary.

12. Check alignment and realign if required (Step #8). Secure shaft mountings firmly.
13. Unlock/start mechanism and test for smooth operation.
14. Stop/lock out mechanism and adjust as necessary.
15. Install guards.
16. Unlock power.

PERFORMANCE OBJECTIVE V-TECS 05

ENABLING OBJECTIVES

Use of a roller chain and sprockets.
Use of hand tools.
Use of measuring tools.
Use straight edge of wire to align sprocket.
Use of safety rules.

LEARNING ACTIVITIES

1. Show how to install lock-out on power supply.
2. Identify the type of chain, links and sprockets.
3. Explain the proper procedure for aligning and tensioning chain drives.
4. Explain the need to check all components for proper fit.
5. Identify the special tools and their use for roller chain.
6. Demonstrate how to install chain drive to proper alignment and tension with all components secured to manufacturer's specifications.
7. Identify the chain pitch by chain number.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide,** pp. 165-182.

EVALUATION

Questions

1. Which of the following provide a positive drive?
    a. Flat belts
    b. Timing belts
    c. V-belts
    d. Chain drive.

2. Chain drives are used to transmit:
    a. Rotary motion
    b. Energy
    c. Horsepower
    d. All of above.

3. Which of the following are critical factors for chain drives?
    a. Proper chain size
    b. Tension
    c. Sprocket alignment
    d. All of above.

Evaluation Continued

4. Which of the following could affect safety of a chain drive?
   a. Tension
   b. Improper guarding
   c. Drive not properly sized
   d. All of above.

Answers
1. b, d
2. d
3. d
4. d

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 06

TASK: Maintain chain and sprocket drives.

CONDITIONS: A malfunctioning chain drive, chain, connecting links, offset links, replacement sprockets, cleaning fluid, and the following supplies, tools and equipment:

Chain detacher(s)
Coupling tool
Drive pins
Fahrenheit thermometer
Feeler bars
Level set
Manufacturer's specifications
Mechanic's tool box (hand tools)
Oil can (with proper lubricant)
Personal safety equipment
Piano wire and tightener
Straightedge.

STANDARD: When completed, the drive will deliver rated power at rated speed smoothly, be free of uneven wear, squealing, high temperature, loose bolts, flapping chain, flying dirt, oil, steam, water, other chemicals, rubbing, binding and unscheduled shutdowns.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., p. 1070.

PERFORMANCE GUIDE

1. Run mechanism at normal rate and load.
2. Check for hot bearings, sprockets and chain.
3. Check for flying dirt, oil, grease, water and other debris.
4. Check for loose, flapping chain.
5. Check for rubbing, squealing, binding parts and loose bolts.
6. Lubricate according to manufacturer's specifications.
7. Stop and lock out machine power.
8. Remove safety guard(s)/inspection plates.
9. Check chain and sprockets for uneven wear and damage. Weld teeth if necessary. Replace if necessary.
10. Check for loose set screws, mounting bolts. Replace and tighten as necessary.
11. Check and correct for chain elongations in accordance with manufacturer's specifications.
12. Disassemble, clean, re-lubricate and reassemble as needed.
13. Replace safety guard(s)/inspection plates.
14. Unlock/start mechanism and test.

PERFORMANCE OBJECTIVE V-TECS 06

Performance Guide Continued

15. Turn off mechanism.
16. Record maintenance and servicing.

ENABLING OBJECTIVES

Use of sight and hearing to verify proper operation.
Use of safety rules.
Use of chain and sprockets.
Use of hand tools.
Use of measuring tools.
Use of straight edge or wire to align sprockets.

LEARNING ACTIVITIES

1. Demonstrate how to install lock-out on power supply.
2. Identify the types of sprockets and chain.
3. Explain the proper procedure for tensioning chain and sprocket alignment.
4. Identify the probable reasons for breakdown by inspection.
5. Explain the reason for cleaning and checking all components for wear and adjustments before installing new components.
6. Show how to install all necessary new components, re-align and tension according to manufacturer's specifications.
7. Discuss how to re-install all safety covers and guards.
8. Direct students in updating maintenance service records to reflect repairs.

RESOURCES

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 178-182.

EVALUATION

Questions

1. Which of the following could effect the performance of a chain drive?
   a. Worn chain
   b. Worn sprocket
   c. Loose sprocket
   d. Bent shaft
   e. All of above.

2. Worn chain or sprockets could cause, which of the following?
   a. Chain to jump sprocket
   b. A safety problem
   c. Production
   d. All of above.

Evaluation Continued

3. Which of the following provide positive drive?
   a. V-belt drive
   b. Gear drive
   c. Chain drive
   d. All of above.

4. #40 roller chain indicates:
   a. 40 links per foot
   b. Width of chain
   c. Pitch of chain
   d. Type of material.

<ins>Answers</ins>

1. e
2. d
3. b, c
4. c

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 07

TASK: Install and align closed gear drives.

CONDITIONS: A gear drive which transmits power from a driver (motor, engine or takeoff shaft) to a driven machine, and the following tools and equipment:

Dial indicator
Feeler bars
Levels
Manufacturer's installation manual
Mechanic's tool box (hand tools)
Personal safety equipment
Piano wire and tightener
Shims, wedges
Straightedge
Tooth gages (set).

STANDARD: When completed, the gear drive should operate smoothly and freely, and deliver full and uniform power without chattering, squealing, binding or misalignment.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 759-789, 837-849, 945-964.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Check driven machine for level. Check hold-down bolts or fasteners for tightness/secureness.
3. Check driver coupling for damage and placement.
4. Inspect gear reducer couplings for damage.
5. Check alignment of gear reducer to driven machine if needed. Loosen gear reducer and align.
6. Insert bed plate if necessary.
7. Fasten down gear reducer.
8. Connect couplers with bolts, grids or other connecting elements.
9. Check driving motor or takeoff shaft coupling for damage.
10. Check driver coupling alignment and align driver coupling with reducer coupling if necessary.
11. Fasten down driver motor.
12. Connect couplers with bolts, grids or other connecting elements.
13. Lubricate according to manufacturer's specifications.
14. Install guards.
15. Unlock/rotate drive slowly and check for rubbing, binding and vibrations.

Performance Guide Continued

16. Stop/lock out drive for realignments as necessary.
17. Unlock/operate drive.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanics handtools.

LEARNING ACTIVITIES

1. Discuss the various types of speed reducers.
2. Point out the importance of precise alignment in installing gear reducers.
3. Indicate the steps to follow in reducer installation and alignment.
4. Demonstrate installation of a gear reducer, align, shim and secure the unit to manufacturer's specifications.
5. Engage the students in repeating the gear reducer installation procedure and check the work for accuracy.

RESOURCES

Plant Engineering Training Systems. Unit 3, Section 9, p. 107.

EVALUATION

Questions

1. The size of a speed reducer is determined by its:
    a. Physical shape
    b. Shaft diameters
    c. Horsepower rating and gear ratio
    d. Lubricant capacity.

2. Proper alignment between two shafts can be checked with a:
    a. Micrometer
    b. Caliper
    c. Straight edge and feeler gauge
    d. Surface gauge.

3. In order to properly align a reducer which must be raised slightly, which device would best accomplish this?
    a. Washers and plates
    b. Spacers and shims
    c. Adjusters
    d. Screw jacks.

Evaluation Continued

Answers
1. b
2. c
3. b

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 08

TASK: Maintain gear drives.

CONDITIONS: A malfunctioning gear drive, lubricants, and the following tools and equipment:

Feeler bars
Grease gun
Levels
Mechanic's tool box (hand tools)
Oil can
Personal safety equipment
Straightedge
Thermometer
Tooth gages
Vibration detector.

STANDARD: When completed the drive will deliver rated power smoothly at rated speed without excessive noise and be free of uneven wear, dirt, high temperature and unscheduled shutdown.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Operate drive at normal rate and load.
2. Check for hot bearings and gear boxes.
3. Check for rubbing, squealing, binding, loose bolts and vibrating parts.
4. Stop/lock out the drive power.
5. Check for excessive backlash by reversing drive.
6. Check for loose couplings.
7. Disassemble, clean, lubricate and reassemble as necessary.
8. Change oil.
9. Check and adjust alignments of reducer to driven machine.
10. Check and adjust alignment of driver to reducer.
11. Tighten all bolts.
12. Unlock/turn on drive. Operate/observe operation.
13. Record maintenance and services.

ENABLING OBJECTIVES

Use of safety rules.
Use of hand tools.
Use of fuel to determine vibrations.

PERFORMANCE OBJECTIVE V-TECS 08

LEARNING ACTIVITIES

1. Point out the need for proper maintenance and inspection of gear reducers.
2. List the check points, and problem symptoms of gear reducer drives.
3. Discuss the principles of lubrication and service life as they apply to gear reducers.
4. Demonstrate the inspection and maintenance procedures for gear reducers.
5. Engage the students in inspecting and servicing gear reducers.

RESOURCES

Plant Engineering Training Systems. Unit 3, Section 9, p. 107.

EVALUATION

Questions

1. Which of the following is required to determine the service factor of a reducer?
    a. Duty cycle
    b. Type of load
    c. Type of prime mover
    d. All of the above.

2. Splash lubrication in parallel shaft speed reducers is aided by:
    a. Oil coolers
    b. Dams and troughs
    c. A single large gear
    d. Large bearings.

3. A lubricator or maintenance man should always routinely check a speed reducer for noise and:
    a. Loose gears
    b. Hot bearings
    c. Gear backlash
    d. Oil viscosity.

Answers

1. d
2. b
3. b

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 09

TASK: Install and align flexible couplings.

CONDITIONS: A flexible coupling, power source with driving shaft, a driven shaft on a machine or any other two rotating sections that need connection, and the following tools and equipment:

Dial Indicator
Fahrenheit thermometer
Levels
Mechanic's tool box (hand tools)
Personal safety equipment
Press or source of heat
Shims, wedges
Straightedge
Taper gage
Vibration detector.

STANDARD: When completed, the job should operate at normal rate and load and deliver full and uniform power without vibration, squealing, binding, rubbing and heat above 180°F.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 685-686.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Disassemble coupling.
3. Shift shaft to allow for clearance if necessary.
4. Position coupling halves onto shaft by:
   a. Press fit
   b. Heat/shrink fit
   c. Key/set screw
   d. Pin/bolt
   e. Other.
5. Rotate and check coupling faces and surfaces and shafts with dial indicator to see that they run true.
6. Adjust to remove runout if possible. If not, see steps 7b, 8b.
7. Align driver vertically to driven shaft by using:
   a. Straightedge and Feelers. Align until faces are parallel. Shim if needed.
   b. Dial Indicator. Attach to driver coupling half with tip in contact with driven coupling half. Rotate one shaft. Check reading at each quarter turn. Shim equal to 1/2 total indicator runout.

PERFORMANCE OBJECTIVE V-TECS 09 Continued

8. Align driver horizontally to driven shaft by using:
    a. Straightedge and Feelers. Align until faces are parallel. Shim if needed.
    b. Dial Indicator. Attach to face of driver shaft coupling half with tip on face near rim of driven half. Rotate driver and shift until zero runout. Set tip on outside surface of driven half. Rotate driver. Move driver transversely (perpendicular to shaft line) until zero runout. Shim.
9. Insert element between coupling halves.
10. Position driver and fasten coupling halves together.
11. Bolt driver in position.
12. Install guards.
13. Unlock/start mechanism.
14. Test for vibrations, binding, squealing, and heat.
15. Stop mechanism.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanics' hand tools.

LEARNING ACTIVITIES

1. Point out the wide variety of flexible coupling types and describe their characteristics.
2. Show several examples of coupling types.
3. Discuss proper procedures for installation and alignment of couplings.
4. Demonstrate installation and alignment of a flexible drive coupling.
5. Engage the students in installing and aligning flexible couplings.

RESOURCES

Plant Engineering Training System, Drive Components, Unit 3, Section 1, pp. 3-4.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 685-686.

EVALUATION

Questions

1. To perform their work properly, most flexible couplings must be designed to:
    a. Couple two shafts together
    b. Allow for some shaft end play
    c. Allow for some shaft misalignment
    d. All of the above.

PERFORMANCE OBJECTIVE V-TECS 09

EVALUATION Continued

2. Of the following which is always required for installing flexible couplings?
   a. Simple hand tools
   b. Precision assembling devices
   c. Hoisting equipment
   d. A hydraulic press.

3. Two methods of checking flexible coupling alignment are by using a straight edge and feeler gauge and by using a:
   a. Caliper
   b. Micrometer
   c. Dial indicator
   d. Rule.

Answers
1. d
2. a
3. c

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 10

TASK: Remove and replace a composition friction-type bearing seal.

CONDITIONS: A bearing installation with worn or damaged seals, gasket cement, seal oil or fluid, high evaporating type cleaning solvent, and the following tools and equipment:

Cleaning rags
Cleaning Solvent
Mechanic's tool box (hand tools)
Personal safety equipment
Seal installation tools (driver, cone guide, sleeve guide, and others approved by seal manufacturer).

STANDARD: When completed, the bearing should operate at rated speed and load with no or slight visible leakage of lubricant for one hour.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen. **Developing Troubleshooting Skills,** pp. 116-119.

Oberg, et al. **Machinery's Handbook,** 21st ed., pp. 554-555.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Determine path of leakage.
3. Clean surrounding surfaces.
4. Remove seal from seat.
5. Check seal for wear and damage.
6. Clean with solvent. Allow to dry.
7. Inspect seal. See if the contact lip has excessive wear, off-center wear, cuts or gouges, or embedded foreign material, such as steel chips. The spring that loads the lip (if there was one) should be in correct position and undamaged.
8. Check shaft for wear and damage.
    a. At the point of seal contact, there should be no deep scratches or nicks.
    b. The shaft should have originally specified machined finish .
    c. Check spline, keyway, or burred end that could have damaged the seal lip on installation.
9. Examine the bore for wear and damage.
    a. Check for nicks or gouges that could cause outside diameter leakage.
    b. Check for coarse machine leads, which could cause spiral leakage.
    c. Check for sharp, unrelieved corners at the bore entrance that could cock and damage the seal outside diameter.

PERFORMANCE OBJECTIVE V-TECS 10

Performance Guide Continued

10. Clean the shaft. File or stone away burrs and bad nicks. Polish the shaft with fine emery to expose a smooth contact for the seal lip. Smooth any sharp corners or edges at the shaft end where the seal first passes over it.
11. Clean the bore area. Remove any nicks, gouges or entrance burrs with emery cloth.
12. Fill the seal with oil or fluid. See specifications. Relieve pressure where necessary. Keep the seal and fluid clean and free of shop dust or dirt.
13. Apply a small amount of oil to the seal lip to aid its passage over the shaft.
14. Coat the bore or the seal outside diameter lightly with gasket cement. If backed by a shoulder, do not allow sealing compound on shoulder side of seal which may cock it.
15. Press the seal into the bore with a factory-approved driving tool, or a driver made with an old bearing outer ring slightly smaller than the seal outside diameter. CAUTION: Protect seal by covering threads, splines, keyways or other sharp edges as necessary.
16. Unlock/operate the newly-installed seal for a few hours to break it in.
17. Stop mechanism and check for heat and excessive leakage.
18. Do not handle without using clean lint free rags after cleaning. Skin contact will speed up rusting of steel components.

ENABLING OBJECTIVES

Use of scales.
Use of hand tools.
Use of measuring tools.
Use of safety rules.
Ability to read prints.

LEARNING ACTIVITIES

1. Demonstrate how to lock-out power supply.
2. Identify types of seals.
3. Identify proper tools to remove seal without damaging unit.
4. Show how to clean and check all components for wear and replacement or repairs as needed.
5. Identify cause for seal failure.
6. Explain corrections necessary before installing new seal.
7. Identify the steps of re-installing to manufacturer's specifications.

PERFORMANCE OBJECTIVE V-TECS 10

RESOURCES

Manufacturer's Specification.

Anderson, Edwin P., **Audels Millwrights Mechanics Guide**, pp. 205-225.

EVALUATION

Questions

1. Which of the following conditions could cause seal failure?
    - a. Nicks on shaft
    - b. Rough machine surface where seal contacts
    - c. Improper fit - seal to shaft
    - d. All of the above.

2. Which of the following is not true?
   Seals are used to prevent:
    - a. Oil or grease leakage
    - b. Trash from entering
    - c. Shaft wear.

3. When inspecting a seal, what should you look for?
    - a. Cuts or grooves
    - b. Embodied foreign material
    - c. Off-center wear
    - d. All of above.

Answers

1. d
2. c
3. d

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 11

TASK: Remove and install mechanical seals.

CONDITIONS: A machine mechanism containing a mechanical seal, and the following tools and equipment:

Manufacturer's manuals
Mechanic's tool box (hand tools)
Personal safety equipment
Scriber
Small drain pan.

STANDARD: When completed, the mechanism should operate smoothly, without leakage of fluid.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Shut off all fluid lines to equipment.
3. Remove coupling from machine mechanism. Catch fluid in pan if necessary.
4. Disassemble machine mechanism to expose seal area.
5. Scribe mark location of old mechanical seal on shaft.
6. Remove old mechanical seal.
7. Inspect housing, bearings and shaft for wear or damage.
8. Install rotating portion of seal on shaft. Check for parallelism of faces.
   CAUTION: Do not cock seal on shaft - tighten down evenly.
   Do not touch seal faces with fingers.
9. Install stationary seal component in end cover.
10. Install end cover on mechanism and bolt together.
11. Install coupling.
12. Turn on all fluid lines.
13. Unlock/turn on machine and test for freedom of operation without binding, squealing or other unusual noises, leaks or excessive heat.

ENABLING OBJECTIVES

Use of safety rules.
Use of mechanical seals.
Use of hand tools.
Use of measuring tools.

PERFORMANCE OBJECTIVE V-TECS 11

LEARNING ACTIVITIES

1. Show how to install lock-out on power supply.
2. Identify types of mechanical seals.
3. Explain correct procedure to remove seal.
4. Clean and inspect all components before installing new seal.
5. Demonstrate the steps of installing a new seal and check for leaks.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 214-224.

EVALUATION

Questions

1. Which of the following statements is incorrect?
    a. Mechanical seals are used in water pumps.
    b. A mechanical seal is pre-loaded.
    c. A mechanical seal will not seal steam or air.
    d. A mechanical seal is used in a rotary joint.

2. Which of the following could damage a new seal?
    a. Scratches on face of seal
    b. A cocked seal on shaft
    c. Faces of seal not parallel
    d. All of the above.

3. The rotating portion of a mechanical seal is mounted on ____________.

Answers

1. c
2. d
3. Shaft end

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 12

TASK: Align pillow blocks and bearings.

CONDITIONS: A mechanical device using pillow block bearings, and the following tools and equipment:

Dial indicator
Level
Manufacturer's manuals
Mechanic's tool box (hand tools)
Personal safety equipment
Shims (various thicknesses)
Wire.

STANDARD: When completed, the bearing should be aligned within one degree.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 604-612.

PERFORMANCE GUIDE

1. Assure shaft is free of nicks, burrs and other damage or wear.
2. Try bearing on shaft for fit.
3. Install pillow block bearing on shaft.
4. Check alignment.
5. Check amount of shim necessary to obtain operating position of bearing and shaft.
6. Fabricate shim(s) if necessary.
7. Install shim(s).
8. Bolt down bearing.
9. Recheck, using level on shaft and bearing areas.
10. Check shaft and bearing for excessive runout by using dial indicator.
11. Check for shaft alignment in bearing by using wire, straightedge, level, and feeler gauges.
12. Check all bolts for tightness.

ENABLING OBJECTIVES

Use of hand tools.
Use measuring tools.
Use of pillow block bearings.
Calculate angles.

PERFORMANCE OBJECTIVE V-TECS 12

LEARNING ACTIVITIES

1. Identify damaged or worn parts.
2. Explain purpose of using shims.
3. Explain use of dial indicator and level used to line up bearings.
4. Identify types of pillow blocks and applications.
5. Explain how to convert degrees to inches.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights Mechanics Guide**, pp. 247-258.

EVALUATION

Questions

1. Pillow block failure results from which of the following?
   a. Weather
   b. Lack of lubrication
   c. Improper installation
   d. All of the above.

2. A dust collector has two pillow blocks - front and rear. The front pillow block is .032 lower than the rear pillow block. Which combination of the following shims would you use?
   .012, .005, .030, .015, .025, .010.

Answers

1. d
2. .012, .005, .015

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 13

TASK: Install pillow block bearings.

CONDITIONS: A mechanical device using pillow block bearings, lubricants, pillow block bearings, and the following tools and equipment:

Dial indicator
Equipment manuals
Grease gun
Level
Mechanic's tool box (hand tools)
Personal safety equipment
Shim stock
Straightedge.

STANDARD: When completed, the bearings must rotate freely, and the bearings and shaft must be within one degree of alignment.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st. ed., pp. 604-612.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Inspect base area for damage and debris.
3. Assure shaft is free of nicks, burrs and damage or wear.
4. Try bearing on shaft for fit. Lubricate lightly. Remove if necessary.
5. Bolt pillow blocks in place.
6. Check bearing for alignment by using dial indicator, level, straightedge, and feeler gages. Loosen and tighten bolts. Shim as needed.
7. Turn bearings freely by hand.
8. Lubricate bearing according to specifications.
9. Unlock/turn on machine and test for freedom of rotation and operation without scratching, squealing, grating or other unusual noises or excessive heat.

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of pillow block bearings.
Calculate angles.

PERFORMANCE OBJECTIVE V-TECS 13

LEARNING ACTIVITIES

1. Show how to install lock-out on power supply.
2. Clean and inspect all components for nicks, wear or other damage.
3. Explain purpose of using shims.
4. Identify types of pillow block bearings.
5. Explain proper procedure in lubrication.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 247-258.

EVALUATION

Questions

1. Pillow block bearing failure results from which of the following?
   a. Excessive heat
   b. Misalignment
   c. Lack of lubrication
   d. All of the above.

2. You have just installed two new pillow blocks. The rear pillow block is .016 low. Which of the following shims would you use?
   .004, .003, .005, .008, .006, .002.

Answers

1. d
2. .003, .005, .008

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 14

TASK: Remove and install bearings in boxes.

CONDITIONS: A mechanical device using bearings, a replacement bearing(s), and the following tools and equipment:

Bearing pullers
Dial indicator
Inside micrometers and outside micrometers
Manufacturers' manuals
Mechanic's tool box (hand tools)
Personal safety equipment
Press or hydraulic ram
Replacement bearings (ball, roller, pin, taper)
Shim stock

STANDARD: When completed, bearings should rotate smoothly and freely, and be within 1/2 degree of true alignment.

SOURCE FOR STANDARD:

Wisconsin Writing Team.

Jansen, **Developing Troubleshooting Skills,** pp. 112-119.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 628-647.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Dismantle mechanism to expose bearings.
3. Inspect bearings for wear and damage.
4. Remove defective bearing.
   a. Ball bearing
   b. Roller bearing
   c. Pin bearing
   d. Taper bearing.
5. Inspect shaft and housing for damage, wear and evidence of bearing slippage.
6. Check parts manual of machine for bearing required.
7. Obtain replacement bearing(s).
8. Check new bearing(s) for roundness, diameters and fit with micrometers.
9. Build up or turndown shaft as necessary.
10. Rebore housing if necessary to install larger bearing.
11. Install replacement bearing(s). Lubricate according to manufacturer's specifications.
12. Check bearing for smooth rotation. NOTE: Taper bearings may have to be shrunk on the shaft.
13. Measure true position of bearing with dial indicator.
14. Unlock/turn on machine and test for freedom of operation without grating, squealing, scratching or other unusual noises and excessive heat.

PERFORMANCE OBJECTIVE V-TECS 14

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of bearings.
Use of bearing pullers.
Use of arbor press and hydraulic press.

LEARNING ACTIVITIES

1. Demonstrate how to install lockout on power supply.
2. Explain proper procedure for removal of bearings from housing using puller or press.
3. Explain proper procedure for installing bearings in housing.
4. Identify effective bearings.
5. Show how to clean and check housing for wear.
6. Explain proper procedure to salvage housing if badly worn.
7. Direct the students to reassemble unit and check for noise and heat as well as vibration.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanic Guide**, pp. 227-282.

EVALUATION

Questions

1. Which of the following is not an Antifriction Bearing?
    a. Ball bearing
    b. Sleeve bearing
    c. Roller bearing.

2. When installing a ball bearing in a housing you should never:
    a. Press against inner race
    b. Press against outer race
    c. Cool bearing with freon.

3. Which of the following statements is not true?
    a. Ball bearings have an inner race, outer race, balls and a retainer.
    b. Thrust bearings carry a radial load.
    c. Taper roller bearings have a cup and cone.

Answers

1. b
2. a
3. b

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 15

TASK: Remove and install sleeve bearing in bores.

CONDITIONS: A mechanical device using sleeve bearings, a replacement bearing and the following tools and equipment:

Mandrels
Manufacturer's specifications
Mechanic's tool box (hand tools)
Micrometers (inside and outside)
Personal safety equipment
Press
Telescope gages.

STANDARD: When completed, the replacement bearing must be free of blurrs or distortion and operate freely.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 548-556, 561-574.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Loosen bolts in bearing block.
3. Raise shaft slightly.
4. Remove bearing block.
5. Remove sleeve bearing from block using hammer and mandrel or press.
6. Check size with telescope gage and micrometer.
7. Clean bore and inspect for damage, cracks and scratches.
8. Obtain replacement bearing. Check for burrs.
9. Check for proper fit in bore.
10. Press or drive in replacement bearing. Align lubrication holes as necessary.
11. Check bearing for distortion with telescope gages or micrometer. Replace, rebore if necessary.
12. Check bearing for proper seating in bore. Replace, rebore if necessary.
13. Place prussian blue on shaft.
14. Slide new bearing on shaft.
15. Lower shaft.
16. Rotate shaft.
17. Remove bearing from shaft.
18. Scrape/clean shaft.
19. Check for burrs.
20. Clean bearing.
21. Lube shaft and bearing.

PERFORMANCE GUIDE Continued

22. Reassemble.
23. Unlock/turn on machine and test for freedom of operation without binding, grating, squealing, scratching or other unusual noises and excessive heat.

ENABLING OBJECTIVES

Use of sleeve bearings.
Use of hand tools.
Use of measuring tools.
Use of scraping tools.
Use of safety precautions.

LEARNING ACTIVITIES

1. Demonstrate how to install lockout on power supply.
2. Identify types of material sleeve bearings are made of.
3. Explain proper procedure to use in removing and installing sleeve bearings.
4. Explain proper procedure for scraping bearing.
5. Identify whether bearing needs reaming or scraping.
6. Direct the students to install bearing fit and reassemble check for binding and heat.

RESOURCES

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 245-257.

EVALUATION

Questions

1. Which of the following are correct sleeve bearings made of?
    a. Oil-lite
    b. Babbit
    c. Bronze
    d. All of the above.

2. Which statement is most true?
    a. Sleeve bearings require more attention than antifriction bearings.
    b. Sleeve bearings are made of wood.
    c. Sleeve bearings are made of nylon.
    d. All of the above.

EVALUATION Continued

3. Sleeve bearings are used in the following:
    a. Motors
    b. Machine tools
    c. Hand tools
    d. Office equipment
    e. All of the above.

Answers

1. d
2. d
3. e

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 16

TASK: Remove and install bearings on shafts.

CONDITIONS: A mechanical device containing bearings on shaft, replacement bearings, lubricant, and the following tools and equipment:

Bearing press
Bearing pullers
Grease gun
Mandrels
Manufacturers' manuals
Mechanic's tool box (hand tools)
Micrometers (inside and outside)
Personal safety equipment
Rags
Replacement bearing (ball, roller, pin, taper)
Telescope gages.

STANDARD: When completed, the bearings and shaft must rotate freely and be within one degree of alignment.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen, **Developing Troubleshooting Skills**, pp. 115-117.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 613-628.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Remove old bearings.
3. Inspect shafts for damage, nicks, burrs or wear.
4. Check shaft outside diameter.
5. Check bearing inside diameter.
6. Check parts manual of machine for bearing required.
7. Select replacement bearing(s).
8. Check bearings and shafts for correct fit with micrometer.
9. Install bearing on shaft using hydraulic ram or presses.
10. Check for proper seating on shaft.
11. Check bearing for distortion and freedom of rotation.
12. Lubricate bearing.
13. Unlock/turn on machine and test for freedom of operation without binding, grating, scratching or other unusual noises and excessive heat.

PERFORMANCE OBJECTIVE V-TECS 16

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of bearings.
Use of bearing puller.
Use of arbor press, hydrualic press or ram.

LEARNING ACTIVITIES

1. Demonstrate how to install lockout on power supply.
2. Explain proper procedures for removal of bearings using puller or press.
3. Explain proper procedures for installing bearings on shaft using heat transfer.
4. Identify defective bearings.
5. Show how to clean and check all components for wear on replacements.
6. Explain proper procedure to salvage shaft if badly worn.
7. Direct the students to reassemble unit and check for performance noise and heat as well as vibration.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 277-282.

American Association of Instructional Materials. Ball and Roller Bearings.

EVALUATION

Questions

1. Ball, roller, needle, bearings are all classed as _________ _________ as bearings.
2. When installing a ball bearing on a shaft you should never:
   a. Press against the outer race
   b. Heat bearings in hot oil
   c. Press against inner race.
3. Which of the following could cause bearing failure?
   a. Dirt
   b. Too much lubrication
   c. Too tight a press on shaft
   d. All of above.
4. Which of the following statements is most true?
   a. Ball bearings have an inner race, outer race and rollers.
   b. Needle bearings can carry thrust load.
   c. Taper roller bearings carry radial and thrust load.

Evaluation Continued

Answers
1. Antifriction
2. a
3. d
4. c

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 17

TASK: Straighten a shaft using a press.

CONDITIONS: A bent shaft and a press, and the following tools and equipment:

Arbor press
Dial indicator
Lathe with headstock/tailstock centers
Mechanic's tool box (hand tools)
Personal safety equipment
Support blocks
Surface plate.

STANDARD: When completed, the shaft must be straight within .002 inch accuracy, and when rotated or rolled on a flat surface, show no indication of being bent.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 455-456.

PERFORMANCE GUIDE

1. Determine length and diameter of shaft.
2. Obtain support blocks. Assure protection of shaft from flat spots when straightening.
3. Locate and mark high spot on shaft.
4. Place center of high point of bent shaft in press.
5. Apply pressure on shaft sufficient to straighten it by operating press. Check amount of spring back.
6. Remove shaft.
7. Roll shaft on surface plate or other known flat surface.
8. Check for straightness with scale.
9. Re-straighten as necessary. Check spring back.
10. Clamp in lathe between centers. Rotate slowly and measure runout with dial indicator.
11. Repeat steps 3-10 until shaft is straight to specifications.

ENABLING OBJECTIVES

Use of metals.
Use of hand tools.
Use of measuring tools.
Use of arbor press.

PERFORMANCE OBJECTIVE V-TECS 17

LEARNING ACTIVITIES

1. Identify type of material before you try to straighten it.
2. Explain how to determine high spot of bent shaft and procedures to straighten it.
3. Explain proper procedure for checking runout of bent shaft.
4. Explain what spring back is.

RESOURCES

Individualized Learning Systems, **103D Shaft Alignment**, pp. 2-4.

EVALUATION

Questions

1. Which of the following shafts will spring back the most?
    - a. Cold roll steel shaft
    - b. Case hardened shaft
    - c. Through hardened shaft.
2. When checking runout of shaft with indicator it will indicate TIR (Total Indicator Runout).
   If the reading was .010 TIR, how much would you have to bend the shaft?
    - a. .010
    - b. .020
    - c. .005
3. Which of the following shafts would be the most difficult to straighten?
    - a. Through hardened shaft
    - b. Cold roll shaft
    - c. Drill rod shaft.

Answers

1. c
2. .005
3. a

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 18

TASK: Replace a shaft.

CONDITIONS: A device containing a shaft that must be replaced, lubricant, replacement shaft, and the following tools and equipment:

Level
Lock for locking out power.
Lifting devices (for large shafts)
Mechanic's tool box (hand tools)
Oil change
Outside micrometers
Personal safety equipment
Rags
Wire.

STANDARD: When completed, shaft and bearings must operate smoothly and freely and be within one degree of alignment.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Dismantle mechanism to expose shaft.
3. Inspect shaft for damage. Remove any burrs or nicks.
4. Remove collars, bearing or other components from shaft. Check/replace as necessary.
5. Remove shaft.
6. Select replacement shaft.
7. Check for proper fit in bores and housings with micrometers.
8. Lubricate shaft.
9. Install shaft.
10. Check for alignment with dial indicators, wire, level, straightedge and feeler gauges.
11. Check for runout and end play with dial indicator.
12. Lubricate bearings.
13. Inspect shaft for freedom of movement in bearings.
14. Unlock/turn on machine and test for freedom of operation without scratching, squealing or other unusual noises or excessive heat.

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of lifting equipment.
Use of safety rules.

PERFORMANCE OBJECTIVES V-TECS 18

LEARNING ACTIVITIES

1. Demonstrate how to install lock out on power supply.
2. Identify from manufacturer's singular manual proper procedures to disassemble unit to expose shaft.
2. Show how to clean and check all components for wear and damage.
4. Identify from manufacturer's manual proper replacement shaft.
5. Explain proper procedures for checking runout and end play of shaft.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Before dismantling a unit to replace a shaft which of the following should be done first?
   a. Clean unit thoroughly
   b. Mark for identification all parts to be removed
   c. Refer to manufacturer's manual
   d. All of the above.
2. Before installing a new shaft you should check for:
   a. Compare new shaft to old shaft
   b. Check for proper size and roundness of bearing surfaces
   c. Check for nicks-burrs-bad threads (general condition)
   d. All of the above.
3. The letters TIR stand for ______ ______ _______.

Answers

1. c
2. d
3. Total indicator reading

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 19

TASK: Install a shaft assembly.

CONDITIONS: A machine needing a shaft assembly, lubricants, and the following tools and equipment:

Lifting devices
Lock for lock out device
Manufacturer's parts manual
Manufacturer's specifications
Mechanic's tool box (hand tools)
Oil can with lubricant
Personal safety equipment
Rags.

STANDARD: When completed, the shaft must turn smoothly and freely and be within specified limits of runout and end play and one degree of alignment.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Inspect bore and housing of machine. Remove burrs and nicks as necessary.
3. Dismantle machine to receive shaft assembly.
4. Check machine parts manual for shaft assembly required.
5. Select shaft assembly.
6. Check shaft assembly for operation, size and fit.
7. Lubricate shaft bearings, other components according to manufacturer's specifications.
8. Slide shaft assembly into position.
9. Secure shaft assembly in place.
10. Check for freedom of movement, runout and end play.
11. Wipe off excess lubricant.
12. Unlock/turn on machine and test for operation without binding, squealing and other unusual noises and excessive heat.

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of lifting equipment.
Use of safety rules.

PERFORMANCE OBJECTIVE V-TECS 19

LEARNING ACTIVITIES

1. Demonstrate how to install lock out on power supply.
2. Identify from manufacturer's manual proper procedures to disassemble unit to remove shaft assembly.
3. Show how to clean and check all components for wear and damage.
4. Explain proper procedures for checking runout and end play of shaft.

RESOURCES

Individualized Learning Systems. **103E Mounting Equipment on Shafts.**

EVALUATION

Questions

1. Before installing new shaft you should check for:
    a. Compare new shaft assembly to old shaft assembly.
    b. Check for nicks, burrs and bad threads.
    c. Check for proper size and roundness or bearing surface.
    d. All of the above.
2. Before disassembly of unit which of the following should be done first?
    a. Clean unit thoroughly.
    b. Refer to manufacturer's manual.
    c. Mark for identification all parts to be removed.
    d. All of the above
3. After new shaft assembly is installed explain how you would check for runout and end play?

Answers

1. d
2. d
3. Indicator

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 20

TASK: Align a shaft.

CONDITIONS: A mechanical device containing a shaft, and the following tools and equipment:

Mechanic's tool box (hand tools)
Personal safety equipment
Rags
Wire
Arbor press
Emery paper - fine
Level
Lifting devices (for large shafts).

STANDARD: When completed, the shaft must turn freely and be within .003 runout, .005 end play, and within one degree of alignment.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out power supply.
2. Rotate shaft and check for freedom of rotation in housing/bore.
3. Inspect shaft for damage. Remove burrs and nicks.
4. Check runout and end play of shaft with dial indicator.
5. Inspect for bent shaft. If bent or damaged, remove, straighten and replace.
6. Inspect bearings of shaft for damage. Replace if necessary.
7. Align shaft using wire and level, and dial indicator.
8. Fasten all bolts and holding devices securely.
9. Recheck shaft for runout and end play with dial indicator.

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of an arbor press.
Use of lifting equipment.
Use of safety.

LEARNING ACTIVITIES

1. Demonstrate how to install lockout on power supply.
2. Identify a bent shaft.
3. Explain how to check a shaft for end play and runout.
4. Explain how to straighten a shaft.

PERFORMANCE OBJECTIVE V-TECS 20

LEARNING ACTIVITIES Continued

5. Identify best method for checking alignment.
6. Show how to clean and check all parts for wear, nicks or other damage.
7. Explain how to figure angles.

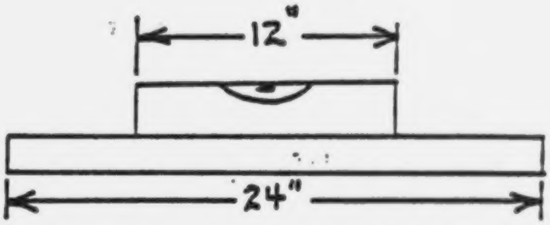
RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 141-144.

EVALUATION

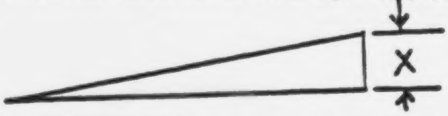
Questions



1. Using a 12" long precision level that indicates you are out approximately 2° how can you use a feeler gauge to determine what size shim to use to correct alignment?
2. Which of the following may be used to straighten a shaft?
   a. Press
   b. Dial indicator
   c. V blocks
   d. All of the above.
3. Which of the following statements is most true?
   a. Shaft run out is measured as T.I.R.
   b. Shaft end play is measured with a scale.
   c. Shaft straightness is measured with micrometers.

Answers

1. Shim under end of level until level reads level, now figure the angle



which will give you "x" in a foot and multiply it by 2.

2. d
3. a

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 21

TASK: Replace universal joint (U-Joint) assembly.

CONDITIONS: A mechanical device containing a universal joint, lubricants, replacement U-Joint assembly, and the following tools and equipment:

Adjustable square (protractor head)
Lifting devices
Lock
Mechanic's tool box (hand tools)
Personal safety equipment
Rags.

STANDARD: When completed, the new universal joint must turn freely without binding or chattering and be guarded.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 683-684.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Gain access to U-Joint.
3. Rotate shaft and determine condition of U-Joint. Analyze for cause of breakdown.
4. Remove U-Joint clips, brackets, locking devices.
5. Disconnect U-Joint from driven shaft.
6. Remove U-Joint from drive shaft.
7. Check shaft for burrs or damage.
8. Check bearings on either side of U-Joint for wear or damage.
9. Measure both shafts with micrometers.
10. Measure distance between shafts.
11. Measure angle of U-Joint and correct it if excessive.
12. Obtain replacement U-Joint.
13. Lubricate U-Joint if needed.
14. Place U-Joint on drive shaft.
15. Check fit of U-Joint by sliding on shafts.
16. Fasten U-Joint to drive shaft.
17. Check installation by rotating by hand.
18. Unlock/"jog" machine slowly.
19. Turn off machine.
20. Tighten U-Joint securely on shafts.
21. Check freedom of movement by rotating by hand.
22. Install guarding device around the coupling.
23. Turn on machine.
24. Listen for indication of binding or rubbing.
25. Check for delivery of power.

PERFORMANCE OBJECTIVE V-TECS 21

ENABLING OBJECTIVES

Use of universal joints.
Use of hand tools.
Use of measuring tools.
Use of lifting devices.
Use of safety.

LEARNING ACTIVITIES

1. Demonstrate how to install lockout on power supply.
2. Identify types of universal joints.
3. Identify condition of U-Joints and probable cause of breakdown.
4. Explain proper procedure for removing U-Joint.
5. Direct students to clean and check all components for wear.
6. Show how to install new U-Joint to manufacturer's specifications, lubricate and check thoroughly.
7. Direct students in re-installing all guards and other safety devices.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Which of the following make up a U-Joint?
    a. Cross
    b. Needle bearings
    c. All of the above.
2. Which of the following statements is not true?
    a. U-Joints provide a positive drive.
    b. U-Joints allow for no misalignment.
    c. U-Joints allow one shaft to be stationary and the other moveable.
3. Which of the following components of a U-Joint is most likely to fail first?
    a. Clamps that hold U-Joint in place
    b. Needle bearings
    c. Rubber boots
    d. Cross.

Answers

1. c
2. b
3. b

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 22

TASK: Disassemble and reassemble universal joint (U-Joint).

CONDITIONS: A universal joint, lubricants, replacement parts, and the following tools and equipment:

Grease gun or oil can
Lifting devices (for large U-Joint parts)
Manufacturer's bulletin and specification sheets
Mechanic's tool box (hand tools)
Personal safety equipment
Wiping rags.

STANDARD: When completed, the joint must be disassembled and reassembled according to the manufacturer's specifications. Reassembled U-Joint must be lubricated according to manufacturer's specifications, operate freely and not bind or show resistance to rotation.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook,** 21st ed., pp. 683-694.

PERFORMANCE GUIDE

1. Determine type of U-Joint by observation.
2. Loosen all bolts, set screws and fasteners on U-Joint, yokes and cross.
3. Remove cross from yokes.
4. Clean all parts according to manufacturer's specifications.
5. Lay out parts on clean surface.
6. Inspect all parts for damage and wear.
7. Measure parts with micrometer.
8. Obtain replacement parts if necessary.
9. Re-lubricate necessary parts.
10. Reassemble cross and yokes.
11. Grease or lubricate complete U-Joint.
12. Wipe off excess lubricant.
13. Check for freedom of movement and rotation.
14. Check all bolts, set screws and fasteners for tightness.

ENABLING OBJECTIVES

Use of U-Joints.
Use of hand tools.
Use of measuring tools.
Use of manufacturer's specification.
Use of lifting devices.

PERFORMANCE OBJECTIVE V-TECS 22

LEARNING ACTIVITIES

1. Identify types of U-Joints.
2. Show how to clean and inspect all components for wear and damage to Manufacturer's Specification.
3. Explain proper procedure for disassembly of U-Joint.
4. Explain proper procedure for reassembly of U-Joint.
5. Explain proper procedure for lubricating U-Joint.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide.**

EVALUATION

Questions

1. Which of the following statements is true?
    a. U-Joints allow for no misalignment.
    b. A U-Joint is a positive drive.
    c. A U-Joint can be used on a right angle drive.
2. Which of the following make up a U-Joint?
    a. Needle bearings
    b. Cross
    c. Rubber boots
    d. All of the above.
3. How would you check the bearing bore for alignment in a yoke or a U-Joint?

Answers

1. b
2. d
3. Hole gage, plug gage, dial bore gage

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 23

TASK: Adjust gibs for free operations.

CONDITIONS: A machine mechanism containing adjustable gibs, lubricants, and the following tools and equipment:

Dial indicator
Feeler gages
Gib wrenches or slotted screwdriver head
Mechanic's tool box (hand tools)
Oil can
Personal safety equipment
Scrapers
Shim stock (assortment of metal shims)
Wiping rags.

STANDARD: When completed, the moving parts must operate freely without binding or side movement with specified clearance.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Remove gibs and wipe/clean gib area(s).
2. Determine gib clearance on both sides and ends with feeler gages.
3. Check sliding surfaces of mechanism for excessive wear with dial indicator and micrometers.
4. Check gib surfaces for excessive wear and galled with dial indicator. Replace, straighten, or scrape if necessary.
5. Adjust gib by loosening screw at small end and tightening screw at large end of gib. Draw up to point of feeling pressure and back off to specified clearance.
6. Lubricate.
7. Operate the mechanism for freedom of operation without side movement.

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of gibs.
Use of scraping.

PERFORMANCE OBJECTIVE V-TECS 23

LEARNING ACTIVITIES

1. Identify types of gibs and function.
2. Explain how to check and adjust gibs.
3. Identify high or low spots in gibs or slide.
4. Explain proper procedure to scrape gib or slide.
5. Demonstrate how to install gib and adjust properly.
6. Explain procedure to perform final check of slide using a dial indicator for horizontal and side movement.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Having scraped two surfaces to obtain proper fit you then flake both surfaces. What is the purpose of flaking?
2. When fitting a gib you use prussian blue on one of the two surfaces. Why?
3. When reworking a slide which of the following should you do first?
   a. Scrape gib flat.
   b. Scrape slide surface that gib rides against flat.
4. What percentage of contact should you have on a scraped surface?
   50% 60% 80%

Answers

1. Lubrication
2. To lubricate high spots
3. b
4. 80%

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 24

TASK: Install safety guards for conveyor system.

CONDITIONS: A conveyor system, safety guards, nuts and bolts, metal or plastic guards, sketches or drawing, and the following tools and equipment:

Drill
Drill bits
Lock
Mechanic's tool box (hand tools)
Metal bending and cutting tools
OSHA regulations manual
Personal safety equipment
Shop Drawing.

STANDARD: When completed, safety guards must be securely fastened and not bind or interfere with operation of conveyor.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Obtain copy of current OSHA regulations for guarding conveyor systems.
2. Inspect all areas of conveyor to be guarded.
3. Lock out conveyor power.
4. Determine clearance for conveyor. Consult OSHA specifications and drawings.
5. Measure and determine fastening points for new guards.
6. Consult manufacturer's catalog and assembly sheets.
7. Try guards on conveyor for fit.
8. Drill, bolt and secure guards to conveyor.
9. Unlock/start conveyor. Inspect for binding and interference during trial run.
10. Re-tighten all bolts, screws and fasteners.

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of OSHA regulations regarding guardings.
Recognize pinch points.
Use of sheet metal tools.
Use of safety rules.

PERFORMANCE OBJECTIVE V-TECS 24

LEARNING ACTIVITIES

1. Demonstrate how to install lock out on power supply.
2. Show how to fabricate a guard.
3. Identify critical areas for guarding.
4. Explain how to update records, prints and or manufacturer's manual to reflect changes made.
5. Identify types of fasteners.
6. Discuss types of materials used for guards.

RESOURCES

Manufacturer's Specifications.

OSHA Regulations on Guarding.

EVALUATION

Questions

1. What do the letters OSHA mean?
2. Which of the following is responsible for the safety of the operator?
    a. Maintenance
    b. Management
    c. Set up man
    d. All of the above.

Answers

1. Occupational Safety and Health Act.
2. d

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 25

TASK: Fabricate and install safety guards for conveyor system.

CONDITIONS: A conveyor system, sketches or drawings, nuts and bolts, metal or plastic material for guards, and the following tools and equipment:

Flexible tape or scale
Lock
Mechanic's tool box (hand tools)
Metal or plastic cutting and bending tools
OSHA regulations manual
Personal safety equipment
Square.

STANDARD: When completed, the guard should be of specified material and design, and fit on conveyor system.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out conveyor power source.
2. Obtain copy of current OSHA regulations for conveyor systems.
3. Inspect area of conveyor to be guarded.
4. Determine clearance for conveyor. Consult OSHA specifications.
5. Measure and determine fastening points for guard.
6. Make sketch and/or blueprint with appropriate measurements included.
7. Select material for guards/brackets.
8. Cut guard/bracket material to size.
9. Form guards/brackets to fit guarded areas.
10. Try guards/brackets on conveyor for fit.
11. Drill holes.
12. Install safety guard.
13. Unlock/start. Check for binding/interference of safety guard.
14. Stop conveyor, and check tightness of fasteners.

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Identify OSHA regulations regarding guarding.
Recognize pinch point.
Use of sheet metal tools.
Use of safety rules.
Use of sketches and drawings.

PERFORMANCE OBJECTIVES V-TECS NO. 25

LEARNING ACTIVITIES

1. Demonstrate how to install lockout on power supply.
2. Identify critical areas for guarding.
3. Identify types of fasteners.
4. Evaluate types of materials used for guards.
5. Discuss best approach or different ways to fabricate a guard.
6. Explain how to up-date records to indicate work performed.

RESOURCES

OSHA Regulations on Guarding.

Manufacturer's Specifications.

EVALUATION

Questions

1. Explain the phrase pinch point.
2. What do letters OSHA mean?
3. Which of the following are responsible for the safety of the operator?
    a. Set up man
    b. Maintenance
    c. Management
    d. All of the above.

Answers

1. Areas at which one can get hurt
2. Occupational Safety and Health Act
3. d

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 26

TASK: Align drive mechanism for conveyor system.

CONDITIONS: A conveyor system with drive mechanism, and the following tools and equipment:

Conveyor specifications
Dial indicator - scales and gages
Lock
Mechanic's tool box (hand tools)
Personal safety equipment.

STANDARD: When completed, the system must operate freely and not slip or make excessive noise, and alignment must be within manufacturer's specifications/tolerances.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Remove guards.
3. Inspect conveyor system, belts, bearings, rollers, and other components for wear and damage.
4. Inspect base area of drive mechanism for damage.
5. Repair/replace any damaged/worn components.
6. Inspect couplings on drive mechanism for wear, damage, alignment.
7. Determine location of drive mechanism by use of scales, gauges and dial indicator. Consult specifications.
8. Loosen bolts of drive mechanism. Re-adjust position and placement if needed.
9. Bolt or fasten drive mechanism in place.
10. Recheck alignment.
11. Check coupling alignment on drive mechanism with gauges and dial indicator.
12. Bolt the aligned mechanism together using coupling, chain and sprocket, or belt and pulley system. Recheck alignment.
13. Recheck all bolts and fasteners.
14. Unlock/start and rotate the drive mechanism for freedom of movement and slippage.
15. Stop/lock out power.
16. Install guarding devices.
17. Unlock/start machine. Check for free operation, excessive noise, binding, rubbing.

PERFORMANCE OBJECTIVE V-TECS 26

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of mechanical drives.
Use of safety rules.

LEARNING ACTIVITIES

1. Demonstrate how to install lockout on power supply.
2. Identify components in conveyor system.
3. Identify drive mechanism.
4. Explain proper procedure for aligning drive mechanism.
5. Explain type of coupling used and proper procedure for aligning it.
6. Check operation of conveyor system before putting into service.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide,** pp. 195-204.

EVALUATION

Questions

1. Which of the following statements is not true?
    a. A chain drive is a positive drive.
    b. A "V" belt is a positive drive.
    c. A coupling provides a positive drive.
    d. All of the above are positive drives.
2. Guards are safety drives used to protect:
    a. Operator
    b. Equipment
    c. Management
    d. All of the above.
3. Explain method you would use to align the drive unit to conveyor.

Answers

1. b
2. d
3. Judgement answers

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS NO. 27

TASK: Assemble conveyor from component parts.

CONDITIONS: New or reconditioned components parts, specifications, lubricants, and the following tools and equipment:

Conveyor manuals and specifications
Grease gun
Lock
Mechanic's tool box (hand tools)
Oil can
Parts for conveyor
Personal safety equipment
Wiping rags.

STANDARD: When completed, the conveyor system must operate freely without binding, vibrations and interference according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out power supply.
2. Lay out all parts for assembly.
3. Check component parts for completeness, damage, wear.
4. Replace/repair parts as necessary.
5. Lubricate parts according to manufacturer's specifications.
6. Determine sequence of assembly.
7. Assemble/install parts loosely in sequence.
8. Check fit of all parts during assembly.
9. Install, align pulleys and belt support devices.
10. Install belts, buckets or conveyor devices.
11. Remove slack and tighten belts and chains.
12. Check all parts for binding and freedom of movement.
13. Align belts and buckets according to manufacturer's manuals and specification sheets.
14. Lubricate assembled conveyor system in accordance with manufacturer's specifications.
15. Turn on/operate system. Check for freedom of operation without binding, vibrations, rubbing and interference.

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Read prints.
Use of safety rules.
Use of conveyors.

PERFORMANCE OBJECTIVE V-TECS 27

LEARNING ACTIVITIES

1. Identify components in a conveyor system.
2. Identify components from assembly drawing.
3. Determine best sequence of assembly.
4. Check components and determine if usable or in need of repair or replacement.
5. Explain proper procedure to exercise in applying lubrication.
6. Explain proper procedure for final check out of assembled unit.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Which of the following would be classified as an antifriction bearing?
    a. Sleeve bearing
    b. Ball bearing
    c. Nylon bearing
    d. All of the above.
2. Explain how to use a belt tension meter.
3. In the event a chain is too long but less than a full link and there is no more take up in driver or driven unit, what would you do?
4. What type lubrication would you use on a chain drive?

Answers

1. b
2. Per Manufacturer's Specifications
3. Use half link.
4. A day film type lubricant

DUTY: ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS

PERFORMANCE OBJECTIVE V-TECS 28

TASK: Install conveyor into material handling system.

CONDITIONS: A conveyor, material handling system, lubricants, nuts and bolts, and the following tools and equipment:

Dial indicator - scales
Grease gun
Manufacturer's specifications
Mechanic's tool box (hand tools)
Oil can
Personal safety equipment
Wiping rags.

STANDARD: When completed, the job must operate freely without binding, vibrations and interference according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out power supply.
2. Inspect conveyor for correct assembly.
3. Inspect gaskets, bearings, shafts and rollers for wear and damage.
4. Lubricate rollers, sprockets and pulleys as needed.
5. Place conveyor in approximate position.
6. Lock out motor drive unit power.
7. Align coupling devices.
8. Align conveyor with level, scales, tape, straightedge, wire, and dial indicators.
9. Bolt conveyor in position.
10. Couple driver to conveyor.
11. Lubricate parts.
12. Unlock/turn on motor unit.
13. Rotate conveyor and check for smooth operation.
14. Recheck all nuts, bolts and fasteners for tightness.
15. Wipe off excess lubrication.
16. Turn off/stop conveyor system.
17. Install guard over couplings.

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Read prints.
Use of safety rules.
Use of conveyors.

PERFORMANCE OBJECTIVE V-TECS 28

LEARNING ACTIVITIES

1. Demonstrate how to install lock out on power supply.
2. Identify size, condition and operation of conveyor to manufacturer's specifications.
3. Identify size and type coupling required for application.
4. Explain proper procedure to align conveyor to material handling system.
5. Identify if guarding complies to safety standards.
6. Explain proper procedure for final check out of system.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Conveyors are used to:
    a. Transfer parts
    b. Handle material
    c. Reduce cost
    d. All of the above.
2. Which of the following statements is not true?
    a. Conveyors can be programmed by a computer.
    b. Conveyors eliminate maintenance.
    c. Conveyors are labor saving devices.
3. Vibration is an item we strive to eliminate in any system. Briefly what causes vibration?
4. Which statement is correct?
    a. Sprocket, pulleys and gears transmit rotary motion.
    b. Motors, belts and chains transmit linear motion.

Answers

1. d
2. b
3. Out of balance components
4. a

MAINTAINING HYDRAULIC SYSTEMS

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 29

TASK: Replace and clean hydraulic strainer/filters.

CONDITIONS: Machinery with a hydraulic system, replacement filter, the following tools and equipment:

Drain pan
Hydraulic fluid
Mechanic's tool box (hand tools)
Personal safety equipment
Solvent for cleaning.

STANDARD: When completed, the strainer and filter will be clean and the system will operate at specified fluid levels without leaks around strainer/filter.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen, **Developing Troubleshooting Skills**, pp. 117-119.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Place drain pan under strainer/filter.
3. Drain strainer/filter.
4. Remove strainer/filter and seals, if any.
5. Clean strainer and seals, if any.
6. Replace filter and seals, if any.
7. Re-install strainer/filter.
8. Check fluid levels. Replenish as necessary.
9. Unlock and start equipment.
10. Inspect for leaks.
11. Turn off equipment.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss contamination removal.
2. Point out the finite range of filtration elements and the degree of filtration.
3. Show the variety of filtering mediums and the types of strainers and filters.

PERFORMANCE OBJECTIVE V-TECS 29

LEARNING ACTIVITIES

4. Demonstrate filter servicing procedures.
5. Engage several students in servicing filters and strainers.

RESOURCES

Plant Engineering Training System, Unit 7, Basic Hydraulics, pp. 35-47.

Industrial Hydraulics Manual. Chapter 5, pp. 5-1 to 5-13.

EVALUATION

Questions

1. The strainer element is usually made of:
   a. Wire mesh
   b. Wound yarn
   c. Sintered bronze
   d. Pleated paper.
2. For a hydraulic system to given maximum service life, it must:
   a. Be operated at low temperature
   b. Be kept clean
   c. Contain additives
   d. Contain resins.
3. When doing maintenance work on a hydraulic system always remember that the system may be:
   a. Under vacuum
   b. Shut down
   c. Pressurized
   d. Isolated.

Answers

1. a
2. b
3. c

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 30

TASK: Refill hydraulic system.

CONDITIONS: A hydraulic system, hydraulic fluid, and the following tools and equipment:

Dirty fluid containers
Lock
Hydraulic fluid
Mechanic's tool box (hand tools)
Personal safety equipment
Transfer pump.

STANDARD: When completed, the system provides immediate response when operated with no leaks.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out power of all equipment/machinery connected to the hydraulic system.
2. Position containers for fluid being removed.
3. Remove fluid. Warm if necessary.
    a. Gravity. Remove drain plug. Allow fluid to drain.
    b. Suction. Use pumps to "suck out" fluid.
4. Inspect reservoir for contaminator in bottom. Remove if necessary.
5. Replace drain plugs.
6. Change filter/strainer if necessary.
7. Refill with fluid.
8. Check fluid level.
9. Check for leaks.
10. Unlock/operate system.
11. Check for leaks.
12. Turn off equipment.

ENABLING OBJECTIVES

None

LEARNING ACTIVITIES

1. Discuss reservoir requirements, such as size and construction.
2. Point out the functions of a reservoir.
3. Discuss factors that would cause a need to replace the hydraulic fluid.
4. List the methods of removing fluid and stress cleanliness of filling equipment.
5. Demonstrate procedures for servicing a hydraulic reservoir and replace the filter if necessary.

PERFORMANCE OBJECTIVE V-TECS 30

RESOURCES

Plant Engineering Training Systems. Unit 7, Basic Hydraulics, pp. 51-63.

Industrial Hydraulic Manual. Chapter 5-1, pp. to 5-13.

EVALUATION

Questions

1. To allow contaminants to settle in a reservoir the fluid:
   a. Moves rapidly
   b. Takes an indirect path
   c. Is cooled
   d. Is aerated.
2. The bottom of a hydraulic reservoir should:
   a. Have a drain plug
   b. Slope toward one end
   c. Be V shaped
   d. All of the above.
3. The hydraulic reservoir serves as:
   a. A store house for fluid
   b. A means to cool fluid
   c. A means to separate contaminants
   d. All of the above.

Answers

1. b
2. d
3. d

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 31

TASK: Align piston (rod) of hydraulic cylinder.

CONDITIONS: A hydraulic system and the following tools and equipment:

Dial indicator
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Shim material.

STANDARD: When completed, the rod will indic[illegible] zero when measured by dial indicator.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen, **Developing Troubleshooting Skills**, pp. 121-123.

PERFORMANCE GUIDE

1. Position dial indicators to ride on the rod while it moves in and out.
2. Cycle machine.
3. Measure side loads.
    a. Loosen mounting bolts.
    b. Shift cylinder until dial indicators measure zero. Shim as necessary.
    c. Tighten mounting bolts.
4. Recycle machine and check indicators for deflection within manufacturer's specifications.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss the importance of properly aligned hydraulic cylinders and the effect of misalignment on service life.
2. Show the variety of various cylinder mount types and discuss the advantages of each.
3. Describe the equipment used and the principles of aligning hydraulic cylinders.
4. Demonstrate the alignment checking and adjusting procedures for several types of hydraulic cylinders.
5. Engage the students in checking and aligning cylinders and check their work for accuracy.

PERFORMANCE OBJECTIVE V-TECS 31

RESOURCES

Industrial Hydraulics Manual. Chapter 6, pp. 6-1 to 6-7.

Plant Engineering Training Systems. Unit 7, Basic Hydraulics, pp. 129-145.

EVALUATION

Questions

1. A side load on a hydraulic cylinder will cause:
    a. A decrease in output pressure
    b. Bushing wear
    c. Seal leakage
    d. All of the above.
2. Hydraulic cylinder mounts may be of what type:
    a. Flange mount
    b. Clevis mount
    c. Trunnion mount
    d. All of the above.
3. The most common type of cylinder problem is:
    a. Cylinder wear
    b. Cylinder leakage
    c. Worn mounts
    d. Scored rod.

Answers

1. b
2. d
3. c

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 32

TASK: Adjust hydraulic pressure.

CONDITIONS: A hydraulic system containing a pressure gauge and pressure control (relief) valve, a specified operating pressure, and the following tools and equipment:

Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment.

STANDARD: When completed, the specified pressure will be indicated on the pressure gauge with the system operating according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Start the system.
2. Read and record the present value on pressure gauge.
3. Unlock pressure control valve stem if so equipped.
4. Adjust pressure to specified reading on pressure gauge by turning pressure control valve stem.
5. Lock valve stem if so equipped.
6. Stop equipment.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanical handtools.

LEARNING ACTIVITIES

1. Discuss the function of the pressure relief valve in the hydraulic system.
2. Stress the importance of proper diagnosis of low system pressure, and the need for accuracy in performing any adjustments.
3. Show a typical hydraulic system and identify its components.
4. Demonstrate the hook up of test equipment, and show the procedure for adjusting the relief valve pressure in accordance with manufacturer's specifications.
5. Engage the students in adjusting hydraulic system pressure. Check their work for accuracy.

PERFORMANCE OBJECTIVE V-TECS NO. 32

RESOURCES

Industrial Hydraulics Manual. Chapter 9, pp. 9-1 to 9-18.

Plant Engineering Training Systems. Unit 7, Basic Hydraulics, pp. 115-127.

EVALUATION

Questions

1. The function of a main pressure relief valve in a hydraulic system is to:
   a. Regulate flow
   b. Regulate pressure
   c. Limit maximum system pressure
   d. All of the above.
2. The pressure at which fluid first begins to flow past a pressure relief valve is known as:
   a. Bypass pressure
   b. Cracking pressure
   c. Pressure limit
   d. Pressure differential.
3. Bottoming the relief valve adjusting screw will cause:
   a. Severe system damage
   b. An oil leak
   c. More power
   d. Loss of power.

Answers

1. c
2. b
3. a

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 33

TASK: Replace hydraulic motor or pump.

CONDITIONS: A hydraulic system, replacement motor or pump, oil, and the following tools and equipment:

Lock
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Scraper
Wire brush.

STANDARD: When completed, motor/pump must operate to manufacturer's specifications at specified pressure and flow with no leaks.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 1022-1027, 1035-1051.

PERFORMANCE GUIDE

1. Lock out system power.
2. Reduce pressure in system.
3. Clean disconnect areas.
4. Remove pump/motor coupling.
5. Disconnect hydraulic lines.
6. Remove mounting bolts.
7. Disconnect electrical power to pump motor.
8. Remove motor/pump.
9. Remove old fittings and install on new pump/motor.
10. Clean mounting surface.
11. Install seals as required.
12. Mount motor/pump to its base.
13. Install mounting bolts loosely.
14. Align motor/pump.
15. Connect coupling(s).
16. Tighten mounting bolts.
17. Reconnect hydraulic lines. Oil seals as necessary.
18. Replace lost fluid.
19. Unlock/start system, operate at specified pressure and flow. Check for leaks.
20. Shut off system.

PERFORMANCE OBJECTIVE V-TECS 33

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

LEARNING ACTIVITIES

1. Point out the importance of proper diagnosis before replacing any hydraulic system component.
2. List the symptoms and causes of poor hydraulic system pump or motor performance.
3. Show how to troubleshoot a hydraulic system using a flow meter and pressure gauge.
4. Demonstrate the removal of a motor or pump.
5. Engage the students in installing the replacement unit, and check their work for accuracy.
6. Set up hydraulic system relief pressure according to manufacturer's specifications, and check system performance.

RESOURCES

Plant Engineering Training Systems. Unit 8, Hydraulic Troubleshooting, pp. 146-159.

Industrial Hydraulics Manual. Chapter 11, pp. 11-1 to 11-34.

EVALUATION

Questions

1. Voids or vacuum bubbles passing through a pump are referred to as pump:
    a. Cavitation
    b. Excavation
    c. Excitation
    d. Entrainment.
2. Any contaminants in the hydraulic system that pass through the pump will cause it to have:
    a. Aeration
    b. Cavitation
    c. Excessive wear
    d. Excessive noise.
3. The vane in a vane motor are held against the motor ring by:
    a. Magnetic force
    b. Centrifugal force
    c. Pneumatic force
    d. Mechanical force.

PERFORMANCE OBJECTIVE V-TECS 33

Evaluation Continued

Answers

1. a
2. b
3. c

Practical Application:

Refer to Checklist Performance Objective V-TECS No. 33.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 33 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 33 EVALUATION

PERFORMANCE TEST FOR INSTALLING A HYDRAULIC PUMP

Student's Name Date

DIRECTIONS TO STUDENT: Replace a hydraulic pump unit, when completed the pump must operate to manufacturer's specifications and be free from leaks, vibration or noise.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. The system power is properly locked out.	____	____
2. The system pressure has been reduced.	____	____
3. The disconnect areas have been cleaned.	____	____
4. The hydraulic lines are removed and plugged.	____	____
5. The pump mounts and coupling are removed properly.	____	____
6. The old fittings are removed and properly installed on the new unit.	____	____
7. Seals are installed if required.	____	____
8. The mounting surface is cleaned.	____	____
9. The pump is aligned properly.	____	____
10. The coupling is properly installed.	____	____
11. The pump mounts are properly tightened.	____	____
12. The hydraulic lines are properly secured.	____	____
13. Lost fluid is replaced.	____	____
14. The system runs within specifications and no leaks.	____	____
15. The machine and equipment are properly cleaned.	____	____

Approved Yes ____ No ____

Directions to Evaluator: All work must be accomplished within a reasonable period of time.
A score of 90 percent is required for competency.

Evaluator's Signature Date

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 34

TASK: Align hydraulic pump or motor.

CONDITIONS: Machinery with a hydraulic system, and the following tools and equipment:

Dial indicator
Mechanic's tool box (hand tools)
Personal safety equipment
Shim material
Straightedge.

STANDARD: When completed, pump or motor will be within one degree of alignment and will operate with no leaks or vibration.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen, **Developing Troubleshooting Skills,** pp. 121-122.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Loosen mounting bolts.
3. Loosen pipe lines/mounts.
4. Loosen drive coupling. Check for damage.
5. Align pump and pipe lines. Use straightedge or piano wire and level. Shim as necessary. Retighten mounting bolts of pump.
6. Align motor coupling to pump vertically by using:
   a. Straightedge and Feelers. Shift until faces are parallel. Shim.
   b. Dial indicator. Attach to driver coupling half with tip in contact with driven coupling half. Rotate shafts together. Shim equal to 1/2 total indicator runout.
7. Align motor coupling to pump horizontally by using:
   a. Straightedge and Feelers. Shift until faces are parallel. Shim.
   b. Dial indicator. Attach to face of driver shaft coupling half with tip on face near rim of driven shaft. Rotate driver and shift until zero runout. Set tip on outside surface of driven half. Rotate driver. Move driver transversely (perpendicular to shaft line) until zero runout. Shim as necessary.
8. Insert element between coupling halves.
9. Fasten coupling halves.
10. Bolt motor (driver) in position.
11. Fasten pipe mounts.
12. Unlock power.
13. Check for vibration, binding and leaks.

PERFORMANCE OBJECTIVE V-TECS NO. 34

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss the importance of accurate alignment between motor and pump for trouble free operation.
2. Point out the two types of alignment and discuss each.
3. Discuss the straightedge and feeler gauge method of aligning shafts.
4. Describe and illustrate the dial indicator method of aligning shafts.
5. Demonstrate both horizontal and vertical alignment of a motor and pump using the feeler gauge and dial indicator methods.
6. Engage the students in aligning pumps and motors and check their work for accuracy.

RESOURCES

Plant Engineering Training Systems, Drive Components, Unit 3, pp. 3-16.

Plant Engineering Training Systems, Hydraulic Troubleshooting, Unit 8, pp. 35-48.

EVALUATION

Questions

1. When joining pump and motor shafts, which of the following is of most importance?
   a. Coupling selection
   b. Alignment
   c. Torque resistance
   d. Base rigidity.
2. Which of these devices are recommended for checking shaft alignment?
   a. Dial indicator
   b. Straightedge
   c. Feeler gauge
   d. All of the above.
3. The best method of coupling a pump shaft to a drive unit is by means of a:
   a. Splined sleeve
   b. Flexible coupling
   c. Flanged coupling
   d. An adapter.

Answers

1. b
2. d
3. b

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 35

TASK: Replace hydraulic gasket and seals.

CONDITIONS: A hydraulic system with faulty seals and gaskets, new seals and gaskets, fluid, and the following tools and equipment:

Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Scraper
Wire brush.

STANDARD: When completed, the seal/gaskets must not leak during system operation.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2343-2448.

PERFORMANCE GUIDE

1. Lock out system power.
2. Locate faulty seals and gaskets.
3. Disconnect drive couplings, if pump or motor.
4. Disconnect hydraulic lines.
5. Remove mounting bolts.
6. Clean mounting surface.
7. Install seals/gaskets included with alternate component. Lubricate as necessary.
8. Position alternate component.
9. Install mounting bolts loosely.
10. Align component with dial indicators and feeler gauges.
11. Connect couplings, if pump or motor.
12. Tighten mounting bolts.
13. Reconnect hydraulic lines.
14. Replace any lost fluid.
15. Unlock/start system and check for leaks.
16. Turn off system.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

PERFORMANCE OBJECTIVE V-TECS 35

LEARNING ACTIVITIES

1. Discuss the principles of hydraulic piping and sealing.
2. Show some examples of various types of tubing, pipe, and hose connections.
3. Emphasize the working pressures vs. bursting pressure of various types of tubing, piping, and hoses.
4. Give some examples of basic flange joints and seal materials.
5. Demonstrate removal, resealing, and replacement of a typical hydraulic pump unit or hydraulic cylinder.
6. Engage the students in resealing similar units.

RESOURCES

Industrial Hydraulics Manual. Chapter 4, pp. 4-1 to 4-23.

Plant Engineering Training Systems. Basic Hydraulics. Unit 7, pp. 83-95.

EVALUATION

Questions

1. A pipe thread seals by means of:
    a. Pipe dope
    b. An interference fit
    c. O-rings
    d. A face seal.
2. A positive seal is one which allows:
    a. A minimum of leakage
    b. No leakage
    c. Easy replacement
    d. Seal flexibility.
3. Three general considerations in preventing leakage are:
    a. Proper design
    b. Proper installation
    c. Control of operating conditions
    d. All of the above.

Answers

1. b
2. b
3. d

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 36

TASK: Install hydraulic line.

CONDITIONS: A hydraulic system with faulty hydraulic line, hydraulic fluid, hydraulic line, fittings, and the following tools and equipment:

Blueprints
Flaring tool
Line cutting tools (for pipe, tubing, hose)
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Pipe threading die.

STANDARD: When completed, there will be no leaks in the line and the system will function according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out system power.
2. Determine type of line to be installed (pipe, tubing or hose).
3. Select fittings/components (elbows, valves, unions, gaskets, seals, etc.).
4. Cut line(s) to length (pipe, tubing or hose).
5. Prepare ends of line(s) (pipe, tubing or hose).
6. Install line/fittings/components (pipe, tubing or hose).
7. Add hydraulic fluid.
8. Unlock/start system and check for leaks.
9. Turn off system.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss the principles of hydraulic piping and sealing.
2. Show some examples of various types of tubing, pipe, and hose fittings.
3. Emphasize the importance of proper fittings for hose, tube or pipe and proper sizing of length.
4. Show some examples of various hoses and tubes.
5. Demonstrate the fabrication of typical hydraulic hoses, piping, and tubing.
6. Engage the students in fabricating similar units.

PERFORMANCE OBJECTIVES V-TECS 36

RESOURCES

Industrial Hydraulics Manual. Chapter 4, pp. 4-23.

Plant Engineering Training Systems. Unit 7, Basic Hydraulics, pp. 83-95.

EVALUATION

Questions

1. Hydraulic hoses are used in applications where:
    a. Short lines are needed.
    b. Flexibility is needed.
    c. The lines are always under pressure.
    d. All of the above.
2. A disadvantage of hoses in hydraulic lines is that they:
    a. Make only temporary connections
    b. Wear from flexing
    c. Insulate against noise
    d. Absorb vibration.
3. Hydraulic lines should be installed:
    a. With special tools
    b. Carefully
    c. Quickly
    d. Without compression fittings.

Answers

1. b
2. b
3. b

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 37

TASK: Replace damaged or faulty hydraulic lines/fittings/components.

CONDITIONS: A hydraulic system, replacement fittings/components, fluid, and the following tools and equipment:

Drain pan
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Scraper
Wire brush.

STANDARD: When completed, the system will operate according to manufacturer's specifications with no leaks.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out system power.
2. Reduce pressure in system.
3. Determine type of lines/fittings/components.
    a. Pipe
    b. Tubing
    c. Hoses
4. Determine damaged/faulty fittings/components.
5. Clean disconnect areas.
6. Position drain pans if needed.
7. Disconnect any hydraulic lines.
8. Remove damaged/faulty fittings/components.
9. Inspect for damage or wear.
10. Clean connecting areas.
11. Select replacement lines/fittings/components.
    a. Pipe
    b. Tubing
    c. Hoses
12. Install any gaskets/seals.
13. Align and connect any drive/driven couplings.
14. Install replacement lines/fittings/components.
15. Reconnect any hydraulic lines.
16. Add hydraulic fluid to specified level.
17. Unlock/start system and check for leaks.
18. Turn off system.

PERFORMANCE OBJECTIVE V-TECS 37

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss the causes of various tube and hose failures.
2. Show some examples of various types of hose and piping failures.
3. Emphasize the importance of proper installation of hydraulic lines.
4. Demonstrate the replacement of typical hydraulic lines.
5. Engage the students in replacing similar units.

RESOURCES

Industrial Hydraulics Manual. Chapter 4, pp. 4-1 to 4-23.

Plant Engineering Training Systems. Basic Hydraulics. Unit 7, pp. 83-95.

EVALUATION

Questions

1. When bending tubing, which of the following applies to the bend?
    a. Must have a round cross section
    b. Must have no flat spots
    c. Must have the proper radius
    d. All of the above.
2. What type of threads are found on hydraulic fittings?
    a. J.I.C.
    b. Pipe
    c. S.A.E.
    d. All of the above.
3. What rating of hose will handle 2000 psi. working pressure?
    a. High pressure
    b. Medium pressure
    c. Low pressure
    d. Neoprene.

Answers

1. d
2. d
3. b

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 38

TASK: Replace valve in a hydraulic system.

CONDITIONS: A hydraulic system, replacement valve, oil, and the following tools and equipment:

Lock
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Wiping rags.

STANDARD: When completed, the hydraulic valve will function with no leaks according to the manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Kirk, et al. **Instrumentation**, vol. 1, pp. 276-282.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Reduce pressure in lines.
3. Disconnect electrical lines as necessary.
4. Clean disconnect area.
5. Disconnect hydraulic lines.
6. Remove mounting bolts.
7. Remove the hydraulic component containing valve.
8. Remove old valve. Check for wear and damage.
9. Install replacement valve. Oil seals as necessary.
10. Reconnect hydraulic lines. Oil seals as necessary.
11. Reconnect electrical lines.
12. Replace any lost oil.
13. Unlock/start equipment and check for leaks.
14. Turn off equipment.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss the variety of valve types and principles of construction.
2. Explain the causes of valve failure and the principles of preventative maintenance.
3. Emphasize the importance of proper installation of hydraulic valves.

PERFORMANCE OBJECTIVE V-TECS 38

Learning Activities Continued

4. Demonstrate the replacement of a typical hydraulic valve.
5. Engage the students in replacing similar units.

RESOURCES

Industrial Hydraulics Manual. chapter 7, pp. 7-1 to 7-30.

Plant Engineering Training Systems. Hydraulic Troubleshooting. Unit 8, p. pp. 114-127.

EVALUATION

Questions

1. Hydraulic valves should be checked out when:
    - a. Starting equipment
    - b. After a routine overhaul or system breakdown
    - c. Every 500 hours of operation
    - d. Before disassembling a system.
2. What should you do before you assume that a valve is faulty?
    - a. Check the maintenance log on the equipment.
    - b. Visually check the system.
    - c. Test the system components.
    - d. All of the above.
3. How should hydraulic valves be installed?
    - a. Cautiously
    - b. With a gauge
    - c. With a sealant
    - d. All of the above.

Answers

1. b
2. d
3. a

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 39

TASK: Measure pressure within a hydraulic system.

CONDITIONS: A hydraulic and the following tools and equipment:

Mechanic's tool box and (hand tools)
Manufacturer's specifications
Personal safety equipment
Pressure gauge (calibrated).

STANDARD: When completed, the pressure reading will be obtained from the pressure gauge, and the system will operate according to manufacturer's specifications without leaks.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Kirk, et al. **Instrumentation**, vol. 1, pp. 175-195.

PERFORMANCE GUIDE

1. Determine point at which pressure reading is to be taken.
2. Reduce pressure.
3. Lock out system power.
4. Install pressure gauge.
5. Unlock/start system and check for leaks.
6. Read pressure gauge.
7. Turn off system/reduce pressure.
8. Remove pressure gauge.
9. Start system and check for operation and leaks.
10. Turn off system.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss the need for pressure testing in troubleshooting the hydraulic system.
2. Explain the methods of connecting pressure testing equipment in hydraulic systems.
3. Emphasize the importance of proper installation of testing equipment and the dangers of fluid under pressure.
4. Demonstrate the installation of pressure testing equipment and the pressure testing of a hydraulic system.
5. Engage the students in testing the system at different points.

PERFORMANCE OBJECTIVE V-TECS 39

RESOURCES

Industrial Hydraulics Manual. Chapter 7, pp. 7-30.

Plant Engineering Training Systems. Unit 8, Hydraulic Troubleshooting, pp. 98-112.

EVALUATION

Questions

1. Gauges are used in troubleshooting hydraulic systems to determine:
    a. Flow volume, pressure and viscosity
    b. Flow volume, pressure and temperature
    c. Flow rate, volume, and pressure
    d. Temperature, viscosity and pressure.
2. What are the functions of snubbers when used with hydraulic gauges?
    a. Provide flexible mountings
    b. Provide manual unloading
    c. Suppress pressure surges
    d. All of the above.
3. When troubleshooting the hydraulic system, the steps become progressively:
    a. Simpler
    b. Harder yet simpler
    c. More complicated
    d. More dangerous.

Answers

1. b
2. c
3. a

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 40

TASK: Inspect pressure control (relief) valve.

CONDITIONS: A hydraulic system, with a pressure control (relief) valve mounted adjacent to the pump with threaded piping connected to its lines, and the following tools and equipment:

Drain pan
Lock
Mechanic's tool box (hand tools)
Personal safety equipment
Wiping rags.

STANDARD: When completed, the valve must relieve pressure on the system at any point within the manufacturer's specified pounds per square inch (PSI) limits with no leaks.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE OBJECTIVE

1. Lock out system power.
2. Reduce pressure.
3. Clean disconnect area.
4. Place drain pan.
5. Remove valve by disconnecting piping.
6. Unscrew lock nut on adjusting screw if exists.
7. Remove pressure from adjusting screw threads by turning adjusting screw.
8. Remove cover.
9. Inspect "O" ring, spring, valve piston and valve body for damage and wear. Replace if necessary.
10. Reassemble valve.
11. Connect valve into system. Oil seals as necessary.
12. Add hydraulic fluid to specific level.
13. Unlock/start system and check for leaks.
14. Adjust/vary pressures to manufacturer's specifications.
15. Adjust to specified pressure.
16. Lock adjusting screw if exists.
17. Shut off system.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

PERFORMANCE OBJECTIVE V-TECS 40

LEARNING ACTIVITIES

1. Discuss the operating principles of relief valves and pressure controls.
2. Show some examples of various types of pressure controls and their applications.
3. Emphasize the importance of cleanliness and proper assembly procedures.
4. Demonstrate the disassembly, inspection and reassembly of a typical relief valve unit.
5. Engage the students inspecting, assembling and adjusting similar units.

RESOURCES

Industrial Hydraulics Manual. Chapter 9, pp. 9-1 to 9-18.

Plant Engineering Training Systems, Basic Hydraulics, Unit 7, pp. 114-128.

EVALUATION

Questions
1. A pressure control valve should be replaced or repaired if:
    a. The piston and bore are scored
    b. The spring is shorter than standard
    c. The piston sticks in the bore
    d. All of the above.
2. A typical main relief valve has ports connected to:
    a. Pressure, return and pilot lines
    b. Pressure and return lines
    c. Inlet, return and compensating lines
    d. Pressure, and inlet lines.
3. A pressure control valve:
    a. Limits maximum system pressure
    b. Provides reduced pilot pressure
    c. Provides reduced operating pressure
    d. All of the above.

Answers
1. d
2. b
3. d

DUTY: MAINTAINING HYDRAULIC SYSTEMS

PERFORMANCE OBJECTIVE V-TECS 41

TASK: Measure flow within hydraulic system.

CONDITIONS: A hydraulic system, a flow measuring device, and the following tools and equipment:

Flow measuring device
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment.

STANDARD: When completed, the flow reading will be within ± one unit of flow and will operate with no leaks according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Kirk, et al. **Instrumentation**, vol. 1, pp. 196-218.

PERFORMANCE GUIDE

1. Determine point at which flow reading is to be taken.
2 Lock out equipment power.
3. Install flow measuring device.
   CAUTION: DO NOT USE A GLASS TUBE DEVICE IN A PRESSURE LINE.
5. Read the flow meter.
6. Turn off system.
7. Remove flow measuring device.
8. Start system and check for leaks.
9. Turn off system.

ENABLING OBJECTIVES

Demonstrate basic skills using mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss the need for flow testing in troubleshooting the hydraulic system.
2. Explain the methods of connecting flow testing equipment in hydraulic systems.
3. Emphasize the importance of proper installation and type of testing equipment and the dangers of fluid under pressure.

LEARNING ACTIVITIES Continued

4. Demonstrate the installation of flow testing equipment and the testing of a hydraulic system.
5. Engage the students in testing the system at different points.

RESOURCES

Plant Engineering Training Systems. Hydraulic Troubleshooting. Unit 8, pp. 98-111.

EVALUATION

Questions

1. Gauges are used in troubleshooting hydraulic systems to determine:
    a. Flow volume, pressure and viscosity
    b. Flow volume, pressure and temperature
    c. Flow rate, volume, and pressure
    d. Temperature, viscosity and pressure.
2. Caution must be exercised when working with pressurized lines because:
    a. They may explode.
    b. They can leak onto the floor and cause a slip.
    c. They are unpredictable.
    d. High pressure fluid can penetrate the skin and cause death.
3. When troubleshooting a hydraulic system:
    a. Tag and lock out switches.
    b. Check the more probable causes.
    c. Use the step by step method.
    d. All of the above.

Answers

1. b
2. a
3. d

INSTALLING AND REMOVING MACHINERY

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE V-TECS 42

TASK: Prepare area for machine installation.

CONDITIONS: Personal safety equipment, manufacturer's recommended mounting procedures, approved location, a floor thickness meeting the manufacturer's specification, and the following tools and equipment:

Blue print locating machinery
Brooms, mops, etc.
Chalk or paint
Floor scraper
Level
Manufacturer's Machine Specifications
Mechanic's tool box (hand tools)
Management location drawing or specification
Personal safety equipment
Recommended mounting devices
Shovel
Tape measure.

STANDARD: When completed, the prepared area will be located and cleaned according to specifications. Mounting devices will be positioned and fastened according to manufacturer's specifications. Overhead clearance will be in accordance with manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Locate the designated area.
2. Shut down and disconnect all air, electric, water and hydraulic feed lines on equipment occupying the designated area.
3. Remove any equipment occupying the designated area.
4. Remove mounting and hold-down devices as necessary.
5. Clean the designated area with shovel, floor scraper, broom, mop.
6. Mark the position of the incoming equipment on the floor with chalk or paint.
7. Position any mounting devices of the incoming equipment recommended by the manufacturer.
8. Secure the mounting devices as recommended by the manufacturer of the incoming equipment.
9. Check for overhead clearance equipment.

ENABLING OBJECTIVES

Interpret blueprints.
Add and subtract whole numbers with fractions.
Read tape measures and rulers.
Use accepted safety practices.

PERFORMANCE OBJECTIVE V-TECS 42

LEARNING ACTIVITIES

1. Orient layout prints to the designated area.
2. Identify and mark all services to area. (Electric, steam, air, water, gas, etc.).
3. Explain the necessity of a clean work area.
4. Describe the proper way to remove old mounting devices.
5. List five mounting devices and explain their proper use.

RESOURCES

Manufacturer's Specifications
Marks. **Standard Handbook for Mechanical Engineers.**
Rockis, et al. **Electrical Motor Controls,** p. 4.
Zozzora, **Engineering Drawing,** pp. 248-259.

EVALUATION

Questions

1. Why are prints drawn to scale?
2. What is the proper color for fire equipment as approved for OSHA?
3. Give three reasons why a clean work area is of benefit in setting machinery.
4. Give three ways to secure a center line to locate mounting location.

Answers

1. Prints are drawn to scale to eliminate any possible error during manufacture, installation or repair. Accurate prints also assist in locating obstructions in the floor or under ground at an installation site.
2. Red
3. a) A clean work area is a safe work area.
   b) A clean work area shows a sense of pride and craftsmanship.
   c) A professional attitude is displayed by a place for everything and everything in its place.
4. Three ways to secure a certain line are:
   a) Point the center line on the floor.
   b) Snap a chalk line.
   c) Suspend a plumb line from an overhead wire which gets the center line above the equipment and safe from damage.

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE V-TECS 43

TASK: Raise machinery using jacks, bars, and blocks.

CONDITIONS: Machinery to be raised, the height required, and the following tools and equipment:

Blocks
Jacks
Level
Lifting bars
Mechanic's tool box (hand tools)
Personal safety equipment.

STANDARD: When completed, machine will rest solidly on blocks at specified height in approximate level upright position.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out machinery power and shut down all feed lines.
2. Disconnect all feed lines (air, water, electric, hydraulic) solidly connected to the equipment to be raised.
3. Disconnect any mounting devices.
4. Position jacks at points which will balance the machine when it is lifted.
5. Raise machine with lifting bars until jacks can be slid under the machine.
6. Raise machine with jacks until sufficient clearance is obtained to insert blocks (2"x2", 2"x4", 4"x4").
7. Lower jacks evenly until equipment is resting on blocks.
8. Remove jacks.

ENABLING OBJECTIVES

Use of jacks, leverages and fulcrum techniques.

LEARNING ACTIVITIES

1. Describe the proper procedure to lock out power.
2. List ways of identifying feed lines before disconnecting them.
3. Demonstrate the technique of leverage and fulcrums using pinch bars.
4. Locate strategic points for positioning jacks.
5. Discuss safe ways to insert blocks.
6. Explain why blocks should be used in several positions.

PERFORMANCE OBJECTIVE V-TECS 43

RESOURCES

Rockis, et al. **Electric Motor Controls,** chapter 1.

EVALUATION

Questions

1. What is an electrical lockout?
2. What is a pinch bar?
3. Name three kinds of jacks.
4. What is a Johnson bar?
5. Name three colors used to identify feed lines.

Answers

1. A device used to lock a panel (using a padlock or several) warning others that the service is being worked on. Each individual on the job should have his own lock on the device so it cannot be turned on until everyone is finished and his/her lock has been removed.
2. A steel bar with a sharp taper on one end used to pry heavy objects or machinery being raised or moved an inch or so at a time.
3. 1) Simpler (Railroad)
   2) Hydraulic
   3) Sizer
4. A pry bar with a long wooden handle and wheels. Used for moving heavy objects.
5. 1) Aluminum
   2) Red
   3) Blue
   4) Oak Brown
   5) Orange
   6) Purple

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE NO. V-TECS 44

TASK: Transport machinery using fork lift.

CONDITIONS: Weight information and machinery, and the following tools and equipment:

Blocks
Chain
Fork lift truck
Jacks
Lifting bars
Mechanic's tool box (hand tools)
Personal safety equipment.

STANDARD: When completed, the machine will have been transported with no damage to equipment or facility.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out power and shut down equipment.
2. Disconnect all feed lines (air, water, electric, hydraulic) to the equipment to be moved.
3. Estimate weight by using manufacturer's specifications.
4. Choose a fork lift truck with sufficient lifting capacity.
5. Raise machine/equipment with lifting bars, blocks and/or jacks high enough to accommodate fork lift.
6. Move the forks under the machine, lift slightly and chain the machine (above center) to the fork lift truck. Make sure chain or strap is not tied around any moving parts of the fork lift.
7. Lift the machine, check for stability, and transport to designated area.
8. Lower into position on blocks.
9. Remove chain.
10. Remove from lift.

ENABLING OBJECTIVES

Use of basic knowledge of rigging.

PERFORMANCE OBJECTIVE V-TECS NO. 44

LEARNING ACTIVITIES

1. Demonstrate the proper procedure to lock out power to a machine using a Volt/Ohm meter.
2. Explain the proper position on the fork lift for maximum lift.
3. Show how to attach a chain to prevent slippage.
4. Explain the safe height to transport a load.
5. Demonstrate the proper (safe) way to block machinery before removing fork lift.

RESOURCES

Manufacturer's Manual and Specifications.

EVALUATION

Questions

1. Name three types of chain hooks.
2. A volt meter is used for what?
3. Why should a load never be transported at full mast extension of the lift?
4. Where is the maximum lift point on the forks?
5. What is a chain sling?

Answers

1. Three types of chain hooks are:
    1. Sling
    2. Grab
    3. Fourdy.
2. A volt meter is used to check for current or load on an electrical circuit before working on it.
3. Always transport a load as close to the ground as possible to prevent danger of dropping it. The higher the load, the more unstable it will be.
4. The maximum lift on the forks is as close to the mast as possible with the mast tilted toward the operator.
5. A sling is two or more chains with hooks connected by a common ring in one end.

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE NO. V-TECS 45

TASK: Transport machinery using overhead crane/chainfall.

CONDITIONS: A machine, personal safety equipment, a crane or a chainfall, and the following tools and equipment:

Chainfall or slings
Lifting bars
Lifting chains
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Support equipment.

STANDARD: When completed, the machine should hang securely in approximate upright position without swaying and is transported without damage to equipment or facility.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Shut down/lock out machine power.
2. Disconnect all feed lines (air, water, electric, hydraulic).
3. Determine machine weight from manual.
4. Select lifting chains or slings consistent with weight of machine.
5. Select chainfall or crane consistent with weight of machine.
6. Attach chainfall hook to overhead equipment (tripod, crane, fork lift, overhead supports) using the safety latches on all hooks.
7. Position lifting chains, slings and support equipment so that no part will be damaged. Consult manufacturer's specifications for hitch points and balance points.
8. Attach lifting chains to hook of chainfall or crane.
   CAUTION: Make sure safety latches are in locked position.
9. Lift the machine. Check for balance. Clear path.
10. Transport to new location.

ENABLING OBJECTIVES

Use of basic knowledge of electricity.
Use of rigging procedures.
Use of safety procedures.

PERFORMANCE OBJECTIVE V-TECS NO. 45

LEARNING ACTIVITIES

1. Demonstrate the proper procedure for electrical lockout.
2. Explain the importance of identifying feed lines.
3. Show safe handling and care of wire rope and chain slings.
4. Discuss the different types of chain falls.
5. Review chain types, construction and uses.

RESOURCES

Manufacturer's Manual and Specifications.

EVALUATION

Questions

1. What is static load?
2. What does the term "proof test" mean when dealing with chain?
3. When inspecting chains what are two of the factors which require immediate repair before use?

Answers

1. The load resulting from a constantly applied force is called static load.
2. "Proof test" is a term designating the tensil test applied to new chain for the purpose of detecting defects in material or manufacture.
3. Cracks, twists, stretch or distortion are some of the reasons to repair a chain before use.

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE V-TECS 46

TASK: Position and secure machinery on foundation.

CONDITIONS: A machine with leveling devices, the new location and machine operator position, and the following tools and equipment:

Level
Lifting bars
Mechanic's tool box (hand tools)
Manufacturer's installation specifications
Mounting equipment
Personal safety equipment
Power tools, drills, etc.
Shims.

STANDARD: When completed, the machine must be level in designated position and fastened to the foundation according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Check preparation of installation area for debris, levelness, and position of mounting devices as per manufacturer's specifications. Prepare area as necessary.
2. Maneuver machinery to predetermined position.
3. Lower to foundation.
4. Level the machine. With a level, check and adjust the position of the machine in the left to right plane, the front to back plane and the diagonal plane until level in all planes. Use shims as necessary.
5. Adjust the machine leveling devices until all three planes show level. Lock hold downs.
6. Secure machine to foundation according to manufacturer's specifications.

ENABLING OBJECTIVES

Use of safety procedures.

LEARNING ACTIVITIES

1. Demonstrate the proper hand signals for use with a crane.
2. Explain why a level should be turned end for end when checking for level.

Learning Activities Continued

3. Define what is meant by plane.
4. Describe the correct procedure used in shimming.
5. Using manufacturer's specifications, show technique using leveling devices.

RESOURCES

Manufacturer's Specifications.

Websters New Ideal Dictionary.

EVALUATION

Questions

1. Which is the correct definition of "plane" as used in Industrial Maintenance ________?
    1. A tool for smoothing a wood surface
    2. A flowering tree
    3. A flat or level material surface
    4. Lacking elevations or depressions
    5. A level of consciousness.
2. A shim is used for:
    1. Leveling
    2. Removing excess space
    3. Cribbing
    4. All of the above.
3. What is the importance of crane hand signals?
4. Define the term "feed line."

Answers

1. The correct definition of the term "plane" as used in industrial maintenance mechanics is "4" lacking elevations or depressions.
2. A shim is used for all the above.
3. What is the importance of crane hand signals? "Communication between operator and guide."
4. "Feed lines" is defined as supply of something essential to operation.

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE V-TECS 47

TASK: Align machinery.

CONDITIONS: A machine to be aligned, and the following tools and equipment:

Dial indicator
Ground test bar
Level
Mechanic's tool box (hand tools)
Manufacturer's specifications
Part specifications
Personal safety equipment
Tool bits or drills.

STANDARD: When completed, the machine will be aligned within manufacturer's specified tolerances.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Fasten dial indicator to the machine member to be used as a positive location point, e.g., (milling machine = the spindle, arbor, column; lathe = the carriage; drill press = the spindle).
3. Traverse the mating machine parts and record the indicator reading.
4. Adjust the leveling devices, individual member adjusting devices or both until indicator shows a deviation within specifications for the operations to be performed.
5. Insert workpiece in machine.
6. Unlock/start machine.
7. Perform selected operation(s) on workpiece.
8. Measure workpiece.
9. Make adjustments as necessary.
10. Turn off machine.

ENABLING OBJECTIVES

Use of safety procedures.
Use of parts specifications.

LEARNING ACTIVITIES

1. Visit a machine shop for a proper demonstration of dial indicators and their uses.
2. Demonstrate the set up technique for dial indicators.

PERFORMANCE OBJECTIVE V-TECS 47

Learning Activities Continued

3. Show reference points on manufacturer's specifications and set machine up using dial indicator.
4. Explain the proper use of a machinist's level.
5. Research levels and report on their uses.

RESOURCES

Johnson, **General Industrial Machine Shop,** p. 122.

Stanley Tool Catalog.

EVALUATION

Questions
1. What is a ground test bar?
2. What is a dial indicator?
3. What is a machinist's level?

Answers
1. A bar with precision ground tolerances.
2. A precision instrument used in setup and machining operations.
3. An instrument filled with alcohol or water in the glasses accurate to .0001" in 12" lengths.

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE V-TECS 48

TASK: Connect machinery to electrical source.

CONDITIONS: The machine to be connected, electrical wire, manufacturer's specifications, and the following equipment:

Local electrical code
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Volt-ohm meter or test leads.

STANDARD: When completed, the machine must operate to its capacity without tripping the circuit breaker and meet manufacturer's and local code specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Connect, according to manufacturer's specifications and local code, from the bus duct to the machine using correct voltage and phase.
3. Jog machine on, then quickly off to check operation. If machine is 3-phase, check direction of rotation. If rotation is incorrect, shut system down at bus duct, disconnect and reverse two specified wires.
4. Unlock/turn on the disconnect at bus duct and again check operation by jogging on, then off.
5. Operate machine at normal capacity.
6. Turn off machine.

ENABLING OBJECTIVES

Use of electrical safety rules.
Use of volt-ohm meters.

LEARNING ACTIVITIES

1. Demonstrate the procedure for locking out power.
2. Research electrical codes and report requirements to class.
3. Diagram the wiring sequence for 220 V. and 440 V. three phase.
4. Explain how to reverse rotation of a three phase motor.
5. Discuss with class the necessity of more than one stop switch on the machine.

PERFORMANCE OBJECTIVE V-TECS NO. 48

RESOURCES

National Electrical Code.

Langley, Electrical Controls for Refrigeration and Air Conditioning.

EVALUATION

Questions

1. In what sequence do you lock out power?
   a. Fuses pulled
   b. Volt meter checked
   c. Pad locked
   d. Trip breaker.
2. What is the function of the green wire in an electrical circuit?
3. Why is there more than one stop switch on a machine?

Answers

1. d, a, b, c
2. The function of the green wire in a circuit is the ground.
3. Emergency safety if the operator is at another location.

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE V-TECS 49

TASK: Connect machine to air or hydraulic source.

CONDITIONS: A machine, source of air or hydraulic power, supply lines, and the following tools and equipment:

A supply of air and hydraulic power
Adaptors and connectors
Mechanic's tool box (hand tools)
Manufacturer's machine specifications
Personal safety equipment.

STANDARD: When completed, the connection must not leak and must be connected according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Locate and determine size of machine inlet (air or hydraulic) lines.
2. Obtain the proper adaptor fittings and connectors.
3. Lock out all power to supply lines.
4. Connect supply lines to machine lines.
5. Unlock power to supply lines and check for leaks.
6. Turn on machine and check for operation according to manufacturer's specifications.
7. Turn off machine.

ENABLING OBJECTIVES

Use of pipe sealants.
Use of safety rules.

LEARNING ACTIVITIES

1. Refer to the pipefitters code then report in class how to properly size service lines.
2. Using machine manufacturer's specifications complete a requisition form for all needed supplies.
3. Explain the various techniques of connecting pipe without leaks.
4. Take a field trip to a local contractor and observe the skills to become a master pipefitter.
5. Discuss with class why some pipe services should be insulated and others not.

PERFORMANCE OBJECTIVE V-TECS 49

RESOURCES

Standard Handbook for Mechanical Engineering, pp. 8-147, 8-200.

Oberg, et al. **Machinery's Handbook.** pp. 2322-2342.

EVALUATION

Questions

1. What is thread dope?
2. Screwed fittings are made of:
   a. Cast iron
   b. Malleable iron
   c. Cast steel
   d. Forged steel
   e. Brass
   f. All of the above.
3. Unions are classified as both screwed and flanged. (True or False)

Answers

1. A compound in liquid, paste or tape form used to lubricate and seal threads in pipe joints to prevent leaks.
2. False
3. True

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE V-TECS 50

TASK: Paint machinery/equipment.

CONDITIONS: A machine, steel brush, cleaning solutions, paint brushes, paint and the following tools and equipment:

Good ventilation and masks
OSHA Manual
Paint brushes
Personal safety equipment
Rags
Steel brush.

STANDARD: When completed, the paint must be evenly distributed over entire surface and with no runs.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out all power sources.
2. Clean machine with steel brush and rags.
3. Remove oil and grease with cleaning solution.
4. Fill in gouges and chipped surfaces with filler and sand smooth.
5. Mask areas not to be painted.
6. Stir/mix paint to consistency.
7. Paint machine according to procedures.
   CAUTION: Ventilate area to remove toxic fumes. Do not paint mating surfaces of movable parts.
8. Clean up.

ENABLING OBJECTIVES

Use of paint and brushes.

LEARNING ACTIVITIES

1. Visit a paint manufacturer's and learn the different uses of paint.
2. Demonstrate knowledge of electrical safety by locking out power.
3. Discuss pros and cons of different cleaning solutions.
4. Visit an auto body shop and become familiar with mixing, applying and finishing filling compounds.
5. Research and define the following terms:
   a. Resins
   b. Pigment
   c. Fire-retardant
   d. Preservatives.

PERFORMANCE OBJECTIVE V-TECS NO. 50

RESOURCES

Standard Handbook for Mechanical Engineers, pp. 6-118, 6-112.

EVALUATION

Questions

1. Before painting a machine, it is necessary to lock out power. (True or False)
2. Gasoline is a good safe cleaning solution. (True or False)
3. All paints require a primer. (True or False)
4. Clean up is the last step in painting. (True or False)
5. Adequate ventilation is a must. (True or False)
6. When painting, a face mask is a good safety practice. (True or False)
7. A good paint job requires preparation. (True or False)

Answers

1. True
2. False
3. False
4. True
5. True
6. True
7. True

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE V-TECS 51

TASK: Block and brace equipment for moving or shipping.

CONDITIONS: A machine/piece of equipment to be moved or shipped, blocking and bracing material, banding material, wire, bolts, nails, and the following tools and equipment:

Hammer, claw
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Steel banding machine
Wood blocks.

STANDARD: When completed, the machine/equipment will be blocked/braced/lashed and secured for movement or shipment in accordance with manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Determine parts which could move during shipment.
2. Cut and install wood blocking and bracing to prevent movement of parts.
3. Secure machine/equipment to skid/pallet if allowable.
4. Wire or steel band loose parts together and fasten to machine/equipment/skid/pallet.

ENABLING OBJECTIVES

Use of safety procedures.
Use of steel banding equipment.

LEARNING ACTIVITIES

1. Discuss the reasons for blocking any moving parts on a machine prior to shipment.
2. Show proper techniques for anchoring machine to skid or pallet to prevent movement.
3. Using manufacturer's specifications, indicate the parts that should be blocked and secured.
4. Check with local transport companies on size and shape and weight of containers to be shipped.
5. Discuss with class what safety equipment would be necessary.

PERFORMANCE OBJECTIVE V-TECS 51

RESOURCES

Manufacturer's Specifications

EVALUATION

Questions

1. It is necessary to block all moving parts.
   (True or False)
2. Nails are the best way to anchor a piece of machinery to a base skid.
   (True or False)
3. Carriage bolts are the best anchor for a machine to skid.
   (True or False)
4. Transportation companies must have insurance on machinery from the load point to destination.
   (True or False)
5. Size and weight are not important.
   (True or False)

Answers

1. True
2. False
3. True
4. True
5. False

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE V-TECS 52

TASK: Crib a piece of equipment to distribute the load over a large area.

CONDITIONS: A machine to be cribbed, cribbing material, and the following tools and equipment:

Blocks
Chainfall or overhead crane
Jacks
Lifting bars
Mechanic's tool box (hand tools)
Manufacturer's manuals
Personal safety equipment.

STANDARD: When completed the machine will be in raised position, level, and securely fastened to foundation mounts according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Disconnect all feed lines (air, water, electric, hydraulic).
3. Determine machine/equipment weight from manufacturer's specifications or an estimating procedure.
4. Loosen/disconnect any mounting devices.
5. Raise machine by either:
    a. Jacks, Bars, Blocks. Raise machine/equipment with lifting bars and/or jacks to specified height.
    b. Chainfall or Overhead Crane. Select and position lift chains or slings so that no part will be damaged. Consult manufacturer's specifications. Attach to chainfall or crane and lift clear of floor. Check for balance and stability. Adjust as necessary. Lift to specified heights.
6. Install cribbing material according to manufacturer's specifications.
7. Level the machine. With a level, check and adjust the position in left to right, front to rear, and diagonal planes. Use shims and cribbing material as necessary.
8. Adjust machine leveling devices until all three planes show level.
9. Secure machine to foundation according to manufacturer's specifications.
10. Connect all feed lines (air, water, electric, hydraulic).

ENABLING OBJECTIVES

Read rules and tape measure.
Operate jacks.

PERFORMANCE OBJECTIVES V-TECS 52

LEARNING ACTIVITIES

1. Discuss what is needed and make out a requisition form for all materials necessary to this operation.
2. Show why it would be beneficial to have long tapered wedges in your cribbing materials.
3. Discuss with class the different types of materials which are available and decide which would be best.
4. Demonstrate the use of a level and explain the different kinds.
5. Review electrical lock out procedures.
6. Use proper safety precautions during cribbing operation.

RESOURCES

National Electrical Code.
Manufacturer's manuals.

EVALUATION

Questions

1. Oak is a better cribbing material than pine.
   (True or False)
2. A new level is always accurate.
   (True or False)
3. Requisitions are a waste of time.
   (True or False)
4. Steel toes and leather gloves should be worn when handling cribbing materials.
   (True or False)
5. Safety glasses are not necessary.
   (True or False)

Answers

1. True
2. False
3. False
4. True
5 False

DUTY: INSTALLING AND REMOVING MACHINERY

PERFORMANCE OBJECTIVE V-TECS 53

TASK: Move machine/equipment with skids or dollies.

CONDITIONS: A machine, new location, and the following tools and equipment:

Blocks
Jacks
Lifting bars
Mechanic's tool box (hand tools)
Personal safety equipment
Skid or dolly
Truck or tractor.

STANDARD: When completed, the machine will be at new location with no damage to equipment or facility.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Shut down all equipment and lock out power.
2. Disconnect all feed lines (air, water, hydraulic, electric).
3. Disconnect any foundation mounting devices.
4. Lay out path of movement. Assure clearances needed.
5. Raise machine with lifting bars and jacks to height needed to accommodate skid or dolly.
6. Place skid or dolly under machine.
7. Lower machine onto skid or dolly.
8. Move machine to new location. Use truck or tractor as necessary.

ENABLING OBJECTIVES

None

LEARNING ACTIVITIES

1. Describe the sequence in locking out power.
2. Research OSHA standards on color codes for gas, compressed air, portable water, fuel oil, fire, first aid, and electrical.
3. Using supplies' catalogs list five possible fastening devices.
4. Explain how to position skids or dolly safely.
5. Using manufacturer's specifications to determine the size of skid for the load with proper safety factor included.
6. Discuss the anchoring technique to fasten machine to skid for transportation.

PERFORMANCE OBJECTIVES V-TECS 53

RESOURCES

OSHA Standard.

Manufacturer's Specifications.

EVALUATION

Questions

1. All fastners are the same.
   (True or False)
2. There is no difference in loads betwen oak and pine timbers.
   (True or False)
3. Green is the color for gas services.
   (True or False)
4. When you lock out power you pull the fuses.
   (True or Fasle)
5. Carriage bolts and lag screws will both work for anchoring to skids.
   (True or False)

Answers

1. False
2. False
3. False
4. True
5. True

MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 54

TASK: Calibrate and adjust thermostat.

CONDITIONS: A heating, ventilating and air conditioning (HVAC) system with faulty or erratic thermostat, sealing compound, and the following tools and equipment:

Control line test gauge
Manufacturer's specifications
Personal safety equipment
Pliers
Screwdrivers
Thermometer
Wiping cloth.

STANDARD: When completed, the thermostat will have been calibrated and adjusted in accordance with manufacturer's specifications and reflect manufacturer's specified accuracy.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Brumbaugh, **Heating, Ventilating and Air Conditioning**, Library vol. 2, pp. 118-121.

PERFORMANCE GUIDE

1. Disconnect circuit or lock out breaker.
2. Locate thermostat.
3. Review manufacturer's specifications.
4. Disassemble thermostat to expose adjusting screws or contact points as necessary.
5. Calibrate and adjust.
    a. Bimetal Strip Temperature Sensor.
        (1) Set the thermostat to cut-in temperature according to manufacturer's specifications.
        (2) Turn adjusting screw or bend contact points to obtain specified temperature by using screwdriver, pliers, and feeler gauges.
        (3) Set thermostat at cut-out temperature according to manufacturer's specifications.
        (4) Turn adjusting screw or bend contact points to obtain specified temperature.
    b. Pneumatic Temperature Controller.
        (1) Set thermostat set-point dial at room temperature.
        (2) Set pressure adjusting screw so the control pressure is at the mid-point of the spring range of the controlled device.
        (3) Turn thermostat dial to the desired control temperature, e.g., 65°F for heating or 78°F for cooling.

Performance Guide Continued

   c. Remote Bulb Sensing Element. Adjust spring/post assembly by turning adjustment nut.
6. Clean or replace defective parts as necessary.
7. Check/adjust operation according to manufacturer's specifications.
8. Seal adjustment screws with compound to prevent loss of calibration as necessary.
9. Reassemble.
10. Unlock power.

ENABLING OBJECTIVES

Read and interpret manufacturer's specifications.
Use a control line tool gauge.

LEARNING ACTIVITIES

1. Instruct students to research thermostats and discuss their function in class.
2. After reviewing manufacturer's specifications explain the procedure for calibration of this thermostat.
3. Restore and implement the electrical safety rules before starting.
4. Diagram a thermostat circuit and explain how it works.
5. Demonstrate calibration procedures using manufacturer's specifications.

RESOURCES

Manufacturer's specifications.

Webster, **Ideal Dictionary**.

EVALUATION

Questions
1. What is calibration?
2. What is a pneumatic control?
3. What is a thermostat?

PERFORMANCE OBJECTIVE V-TECS 54

Evaluation Continued

Answers

1. To determine the correct measure according to a preset scale or marker.
2. Controls operated by air pressure.
3. An automatic temperature sensing device used for regulating temperatures.

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 55

TASK: Lubricate air compressor.

CONDITIONS: A pneumatic system with an air compressor, lubricants, and the following tools and equipment:

Grease gun
Oil can
Personal safety equipment
Wiping rags.

STANDARD: When completed, all lubricating points and fittings must be lubricated using manufacturer's specified lubricant grades and be reassembled to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Anderson, **Home Refrigeration and Air Conditioning**, p. 160.

PERFORMANCE GUIDE

1. Lock out system power.
2. Drain water/liquid from air tank.
3. Disassemble machinery/equipment to expose lubricating points as necessary.
4. Inspect for defective or worn parts. Repair or report as necessary.
5. Clean oiling points and add oil according to manufacturer's specifications.
6. Clean lubrication fittings and lubricate according to manufacturer's specifications.
7. Reassemble machinery/equipment.
8. Unlock/start power unit to build up specified pressure as necessary.
9. Check operation in accordance with manufacturer's specifications.
10. Turn off equipment.

ENABLING OBJECTIVES

Use a pneumatic system with an air compressor.
Identify various types of lubricants.

LEARNING ACTIVITIES

1. Reseach compressor lubricants and report to class.

Learning Activities Continued

2. Have a local supplier of lubricants give a lecture to the class on applications.
3. Describe the proper cleaning procedure prior to lubrication.
4. Discuss F.L.R. systems with class.
5. Explain how an air filter on the intake is of benefit to the compressor.

RESOURCES

Manufacturer's Specifications.

Webster. **Ideal Dictionary.**

EVALUATION

Questions

1. What is viscosity?
2. Why should wiping rags be included in equipment needed?
3. Why is an air filter necessary on the intake side of the compressor?

Answers

1. The flowing ability of a liquid due to its molecular structure.
2. To remove all dirt and contaminated lubricants from fittings or cups before relubrication.
3. To prevent dirt and grit from entering the compressor causing damage.

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 56

TASK: Disassemble/reassemble air compressor.

CONDITIONS: An air compressor unit, replacement parts, lubricants, and the following tools and equipment:

Grease gun
Mechanic's tool box (hand tools)
Manufacturer's specifications
Oil can
Micrometers (inside and outside)
Personal safety equipment
Wiping rags.

STANDARD: When completed, the air compressor will have been disassembled, reassembled and will operate according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Review manufacturer's manual.
2. Disconnect circuit or lock out breaker.
3. Shut off air supply.
4. Release air pressure.
5. Drain or pump out fluid as necessary.
6. Disconnect inlet and output pipelines and electrical circuits as necessary.
7. Remove compressor from mounts.
8. Disassemble casing and/or remove cover plates.
9. Remove diaphragm and seals.
10. Remove impeller or piston assembly.
11. Clean and inspect parts for wear and damage according to manufacturer's specifications. Replace as necessary.
12. Place impeller or piston into casing.
13. Align diaphragm and seals to spindle or piston rod with upper and lower casing by using lead wires, micrometers and calipers.
14. Assemble casing and/or cover plates.
15. Remount on platform or floor.
16. Connect inlet and output pipelines.
17. Turn on air supply.
18. Lubricate as necessary.
19. Unlock/start system and test operation.
20. Adjust to specifications.
21. Turn off system.

PERFORMANCE OBJECTIVE V-TECS 56

ENABLING OBJECTIVES

Use hand tools.
Read and interpret manufacturer's specifications.

LEARNING ACTIVITIES

1. Differentiate between services on compressor and close down system.
2. Identify safety using manufacturer's specifications.
3. Locate seals on specifications and describe proper removal procedures.
4. Research and report on compressor lubricants.
5. Evaluate the degree of damage or wear.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Any lubrication will work for compressors.
   (True or False)
2. Lockout power is a good safety practice to follow.
   (True or False)
3. You should bleed pressure before disconnecting air lines.
   (True or False)

Answers

1. False
2. True
3. True

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 57

TASK: Install air compressor.

CONDITIONS: An air compressor, mounting surface, installation lines and fittings, controls, specifications for installation, and the following tools and equipment:

Dial indicator
Mechanic's tool box (hand tools)
Manufacturer's installation specifications
Personal safety equipment
Shim material
Straightedge
Wire brush.

STANDARD: When completed, the compressor will be installed according to specifications and provide continuous air supply to pneumatic tools and equipment in accordance with manufacturer's specifications.

SOURCE FOR STANDARD
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Inspect installation area for levelness and freedom from debris.
2. Place compressor on mounting surface.
3. Locate inlet and outlet terminals.
4. Determine location of fittings (valves, unions, gages, controls, etc.).
5. Select fittings.
6. Cut pipe lines to length.
7. Prepare ends of lines.
8. Assemble-install lines, fittings, components, seals as necessary.
9. Install mounting bolts.
10. Align compressor by using dial indicator or straightedge and shims as necessary.
    a. Direct Drive. Align and connect drive coupling as necessary.
    b. Indirect Drive. Install and align motor after compressor is tightened in place. Tension belt according to manufacturer's specifications.
11. Tighten mounting bolts.
12. Install and align motor if indirect drive.
13. Connect pipelines from input and to output.
14. Set automatic controls as necessary.
15. Lubricate as necessary.
16. Start system and observe operation. Check for leaks.

Learning Activities Continued

17. Adjust controls to maintain specified pressure, speed, temperature and cycling as necessary.
18. Turn off system.

ENABLING OBJECTIVES

Read a tape measure.
Read and interpret manufacturer's specifications.

LEARNING ACTIVITIES

1. Define shim material and its use.
2. Compile a list of needed parts for installation and complete a requisition slip.
3. Have a lubrication specialist lecture class on compressor oils.
4. Explain the use of F.L.R.
5. Review safety rules and describe equipment needed for this job.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. A direct coupling can be checked for alignment by the following methods:
   a. Straight edge
   b. Feeler gauge
   c. Dial indicator
   d. None of the above
   e. All of the above.
2. Input/output means your speed and ability to do the job.
   (True or False)
3. A limit switch is a safety device.
   (True or False)

Answers

1. e
2. False
3. True

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 58

TASK: Install/replace fan guards, shrouds or mesh covers.

CONDITIONS: A heating/air conditioning system with a fan, lubricants, and the following tools and equipment:

Compressed air/steam
Grease gun
Manufacturer's specifications
Oil can
Open ended wrenches
Personal safety equipment
Pliers
Screwdrivers
Steel brush
Wiping rags

STANDARD: When completed, the fan guards, shrouds or mesh covers will have been cleaned, installed or replaced according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out system power.
2. Remove old fan guard, shroud or mesh cover.
3. Clean and examine for damage, corrosion or wear. Replace if necessary.
4. Clean and adjust fan blades, housing and ducts as necessary.
5. Lubricate fan as necessary.
6. Position guard, shroud or cover on fan housing.
7. Fasten to housing.
8. Unlock/test for noise/vibration/operation in accordance with manufacturer's specifications.
9. Turn off system.

ENABLING OBJECTIVES

Read and interpret manufacturer's specifications.
Use hand tools.

PERFORMANCE OBJECTIVE V-TECS 58

LEARNING ACTIVITIES

1. Restate safety procedure for the use of compressed air in cleaning operations.
2. Discuss with class the necessity of guards, shrouds and covers.
3. State dangers in not locking out power before removing guards, shrouds and covers.
4. Using the manufacturer's specifications describe the proper setting for adjustable blades to obtain maximum air flow.
5. Describe why guards, etc. should be clean.

RESOURCES

OSHA Regulations.

Manufacturer's Specifications.

EVALUATION

Questions

1. Clean guards and shrouds make for more efficient operation.
   (True or False)
2. Manufacturer's Specifications are the best source of information for adjustment of blades.
   (True or False)
3. Compressed air is not a safety hazard.
   (True or False)

Answers

1. True
2. True
3. False

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 59

TASK: Replace mechanical roof ventilators.

CONDITIONS: A defective mechanical roof ventilator, a roof, replacement ventilator, roofing and flashing materials, and the following tools and equipment:

Roofing knife
Screwdrivers
Tin snips
Wrenches, open end
Hammer, claw
Ladder or access to roof
Lubrication oil
Manufacturer's specifications/catalog
Personal safety equipment
Pliers.

STANDARD: When completed, the roof will not leak and the roof ventilator will have been installed according to the manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out power source.
2. Remove flashing material as necessary.
3. Loosen/remove mounting/duct work screws/bolts/fasteners.
4. Disconnect electrical circuits as necessary.
5. Remove ventilator.
6. Replace/repair roofing material as necessary.
7. Position new ventilator.
8. Connect electrical circuits as necessary.
9. Lubricate as necessary.
10. Fasten ventilator to duct work/roof as necessary.
11. Replace flashing to prevent roof leaks.
12. Unlock power source.

ENABLING OBJECTIVES

Read and interpret manufacturer's specifications.
Use hand tools.

PERFORMANCE OBJECTIVE V-TECS 59

LEARNING ACTIVITIES

1. Identify the proper tools used for sheet metal fabrication.
2. Demonstrate how to fabricate new flashing using existing dimensions and sheet metal tools.
3. Describe the proper use and care of ladders and scaffolding.
4. Tour a roofing company and observe the procedure of a built up roof construction.
5. Visit a sheet metal shop and observe professionals at work.
6. Instruct students to research the various kinds of ventilators and report to the class their use.

RESOURCES

Baumeister, Mark's, **Standard Handbook for Mechanical Engineers,** pp. 14-56.

EVALUATION

Questions

1. Why should a power source be locked out before working on a ventilator?
2. What is a built up roof?
3. What is a membrane roof?
4. Why is flashing necessary?

Answers

1. To prevent electrical shocks.
2. Layer of felt paper, hot tar, (3-5 layers) covered with pea gravel.
3. A vulcanized rubber sheet covering the entire roof as one piece.
4. Flashing seals the edge of the roof preventing water from getting under the cover.

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 60

TASK: Clean and lubricate fans/ventilators.

CONDITIONS: A heating/air conditioning system with a fan/ventilator, cleaning solvent, lubricants, and the following tools and equipment:

Compressed air/steam
Grease gun
Mechanic's tool box (hand tools)
Manufacturer's specifications
Oil can
Personal safety equipment
Steel brush
Wiping rags.

STANDARD: When completed, the fan/ventilator will have been lubricated according to specifications. All components will have been inspected, cleaned and reassembled.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Locate fan/ventilator.
2. Lock out system power.
3. Remove guards, shrouds, covers and clean as necessary.
4. Locate, clean oiling points and add oil according to manufacturer's specifications.
5. Locate, clean, grease fittings according to manufacturer's specifications.
6. Clean fan blades, housings, dampers and duct work as necessary.
7. Adjust fan blades as necessary.
8. Clean, replace air filters as necessary.
9. Check belt for damage. Replace as necessary.
10. Adjust belt tension as necessary.
11. Fasten guards, shrouds, covers.
12. Unlock/check operation according to manufacturer's specifications.
13. Turn off equipment.

ENABLING OBJECTIVES

Read and interpret manufacturer's specifications.
Use hand tools.

PERFORMANCE OBJECTIVE V-TECS 60

LEARNING ACTIVITIES

1. Discuss the proper cleaning procedure using solvents and list the safety hazards.
2. Explain the proper kinds of lubrication to be used.
3. Have a lubrication supplier give a lecture on the proper oil or grease for the job.
4. Show a difference between a clean fan and a dirty fan for air flow.
5. Demonstrate proper tension for all drive belts.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Compressed air should be used with caution and respect.
   (True or False)
2. Testing power source with a meter is good safety procedure.
   (True or False)
3. Belt tension is critical for proper fan operation.
   (True or False)

Answers

1. True
2. True
3. True

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 61

TASK: Calibrate and adjust airflow controls.

CONDITIONS: A heating, ventilating and air conditioning (HVAC) system with erratic airflow and pressures, temperatures, relative humidities, schematic of duct system indicating all design airflows and pressures, and the following tools and equipment:

Anemometer (air velocity meter)
Mechanic's tool box (hand tools)
Manometer (air pressure) indicator
Manufacturer's specifications
Personal safety equipment
Ventilation code.

STANDARD: When completed, the airflow controls will have calibrated and adjusted, and will operate the HVAC system within ten percent of design specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Review ventilation code requirements for building/zones/rooms.
2. Analyze manufacturer's specifications for operation of system.
3. Analyze schematic of duct system(s) for location of dampers, fans, diffusers, mixers and terminals (registers and ventilators).
4. Determine how much ventilation air and outside air is needed in each building/zone/room by analyzing schematic of duct system for design airflows and air pressures.
5. Calibrate and adjust manometer. Disconnect tubes from duct. Check for freedom of movement of liquid. Check to see if pressure range is adequate. Adjust fluid level to zero. Replace if necessary.
6. Calibrate and adjust velocity meter. Disconnect from duct. Connect test instrument and velocity meters in same airflow duct. Compare readings at bottom, middle and top of velocity scales. Calibrate velocity meter with test instruments by adjusting calibration screw.
7. Measure actual airflows and air pressures for branch ducts and terminals (registers) with manometer and air velocity meter.
8. Determine adjustments for airflow and air pressure for branch ducts and terminals by comparing actual airflows and air pressures with design airflows and air pressures.
9. Adjust branch duct damper positions. Check/adjust closure. Replace seals if necessary. Check damper activators for mechanical functioning. Adjust for "spring range shift" by turning spring post nut as necessary. Dampers and activators should operate freely and respond to controls correctly.

Learning Activities Continued

10. Measure/calculate main duct airflow and air pressure to and from fan(s). If more than 15% of sums of duct data, set up conditions for retest of operations.
11. Determine adjustments for airflow and air pressure for main duct(s) by comparing actual airflows and air pressures with design airflows and air pressures.
12. Adjust main duct's damper(s) positions. Check for operation and closure. Replace seals if necessary. Check activators for mechanical functioning. Adjust/clean/lubricate as necessary.
13. Sequence controls.
    a. Determine when minimum, maximum and modulated outside air should be delivered.
    b. Determine best switch-over times.
    c. Adjust time clocks for operation of fans.
14. Adjust controls. Remove covers. Move/adjust controls to regulate cut-in and cut-out limits and speeds of fans. Move/adjust controls to regulate dampers and terminals as necessary.
15. Operate and test system by measuring airflow, air pressure, temperatures, relative humidities, cut-in and cut-out times and sequencing.

ENABLING OBJECTIVES

Read and interpret manufacturer's specifications.

Use a manometer.

LEARNING ACTIVITIES

1. Explain the function of the anemometer.
2. Explain the function of the manometer.
3. Instruct students to research airflow charts relating them to sizing duct work and fan sizing for residental industrial or school ventilation.
4. Show how different ventilator settings will change airflow.
5. Discuss work cycles and peak usage in regards to system controls.

RESOURCES

Manufacturer's Specifications.

Baumeister Mark's, **Standard Handbook for Mechanical Engineers**, pp. 12-96, 12-103.

Swain, et al. **Power Handbook**, pp. 54-55.

PERFORMANCE OBJECTIVE V-TECS 61

EVALUATION

Questions

1. Air flow changes with contamination build up in the duct work. (True or False)
2. Velocity will change with duct size and turns in the line. (True or False)
3. Manometer or anemometer are both used to determine air flow. (True or False)

Answers

1. True
2. True
3. True

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 62

TASK: Calibrate and adjust humidistats.

CONDITIONS: A heating/air conditioning system with a malfunctioning humidistat, humidity specifications, and the following tools and equipment:

Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Test hygrometer or psychrometer

STANDARD: When completed, the humidistat will have been calibrated and adjusted to regulate the relative humidity in accordance with manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Locate humidistat.
2. Measure relative humidity with test hygrometer or psychrometer.
3. Compare readings with humidistat settings.
4. Disconnect electrical circuit or lock out breaker.
5. Dismantle humidistat to expose control and adjusting elements.
6. Check hydroscopic element for expansion and contraction with changes in moisture in air.
7. Determine if control needs adjustment or replacement. Replace as necessary.
8. Adjust "set-points." Lower in fall to 30% RH. Raise in spring to 60% RH.
9. Replace covers.
10. Unlock/turn on electrical power.
11. Test to manufacturer's specifications.

ENABLING OBJECTIVES

Read and interpret manufacturer's specifications.

Use a test hygrometer on psychrometer.

LEARNING ACTIVITIES

1. Discuss humidistats and their functions.
2. Check humidity charts and flow charts then discuss set up procedures with classmates.

PERFORMANCE OBJECTIVE V-TECS 62

Learning Activities Continued

3. Review lock out sequence for power supply.
4. Familiarize students with test instruments.
5. Define the following terms:
    - a. Air density
    - b. Relative humidity
    - c. Hygrometers.

RESOURCES

Baumeister, Mark's, **Standard Handbook for Mechanical Engineers,** pp. 14-43.

Manufacturer's Specifications.

EVALUATION

Questions	Answers
1. What is a humidistat?	1. A controlled spray unit which introduces water vapor into the air stream.
2. What is a hygrometer?	2. An instrument to measure water content in the atmosphere.
3. What does RH mean?	3. Relative humidity amount of vapor present in relation to saturated vapor.

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 63

TASK: Calibrate and adjust pneumatic controls.

CONDITIONS: A pneumatic line with malfunctioning pneumatic controls, and the following tools and equipment:

Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Pneumatic controls test equipment

STANDARD: When completed, the pneumatic output will respond to pneumatic input, and output readings will be in accordance to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Kirk, et al. **Instrumentation**, 3rd ed., pp. 110-112.

PERFORMANCE GUIDE

1. Lock out system power.
2. Locate and determine type of pneumatic controls.
3. Review manufacturer's specifications.
4. Remove cover(s) to expose adjusting dials and screws.
5. Inspect for damage or worn parts. Replace as necessary.
6. Activate air compressor/air supply.
7. Adjust input air control valve to pressure according to manufacturer's specifications.
8. Set output pressure according to manufacturer's specifications.
9. Correct deviations from specifications by adjusting reset, derivative and proportional band dials and screws, air control relay valve, bimetal strip, flapper, or control-setting-index knob as necessary.
10. Replace cover(s).
11. Unlock/test operation to manufacturer's specifications.

ENABLING OBJECTIVES

Read and interpret manufacturer's specifications.

Use pneumatic controls to test equipment.

PERFORMANCE OBJECTIVE V-TECS 63

LEARNING ACTIVITIES

1. Describe proper lockout procedures then employ them.
2. Have a controls supplier give a lecture on controls.
3. Using specifications, discuss the proper settings for high low settings.
4. Demonstrate how adjustments are made accurately.
5. Explain how to use test equipment for this job.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Lockout procedures are to:
    a. Prevent shock;
    b. Secure system for repairs;
    c. Warn others that system is not to be energized;
    d. None of these;
    e. All of the these.
2. All controls have the same high-low span.
   (True or False)
3. Test meters should be used before working on any system.
   (True or False)

Answers

1. e
2. False
3. True

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 64

TASK: Calibrate and adjust pressure controls.

CONDITIONS: An air pipeline containing pressure gauges and pressure control valves, specified operating pressures, and the following tools and equipment:

Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment.

STANDARD: When completed, the specified pressures will be indicated on the pressure gauges within manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Kirk, et al. **Instrumentation,** 3rd ed., pp. 289-292.

PERFORMANCE GUIDE

1. Start the system.
2. Read and record the present values on pressure gauges.
3. Determine control adjustments to be made.
4. Remove covers as necessary.
5. Inspect parts for damage, wear and freedom of operation.
6. Adjust pressure to specified readings on pressure gauges by loosening and adjusting needle valve.
7. Lock needle valve.
8. Replace covers.
9. Test/adjust operational pressures and readings to manufacturer's specifications.

ENABLING OBJECTIVES

Read and interpret manufacturer's recommendations.

LEARNING ACTIVITIES

1. Instruct students to research pressure controls pertaining to heating/air conditioning systems.
2. Visit a company which calibrates instruments for a demonstration.
3. Discuss F.R.L.'s and their function in control systems.
4. Research and discuss pressure regulators.
5. Diagram a pressure control system showing all pertinent components.

PERFORMANCE OBJECTIVE V-TECS 64

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. All pressure controls are the same. (True or False)
2. What are F.R.L.'s?
3. There are set limits on regulators. (True or False)

Answers

1. False
2. Filter, regulator, lubricator systems
3. True

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 65

TASK: Replace air filters.

CONDITIONS: A heating/air conditioning system containing dirty or defective air filter, replacement air filter, cleaning solvents, and the following tools and equipment:

Adjustable wrench
Manufacturer's specifications
Personal safety equipment
Screwdrivers
Steel brush
Wiping rags
Oil can (with lubricant).

STANDARD: When completed, the air filter components will have been inspected for damage and wear, cleaned, and reassembled.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Locate air filter.
2. Lock out system power.
3. Remove cover, door or dismantle systems to expose air filter.
4. Loosen fasteners if applicable.
5. Remove filter.
6. Clean ducts, filter supports as necessary.
7. Inspect any dampers, belts, fans, ducts for damage and wear.
8. Install filter according to manufacturer's specifications.
9. Re-attach cover, door or reassemble system to enclose filter.
10. Unlock power.

ENABLING OBJECTIVES

Read and interpret manufacturer's specifications.

Use hand tools.

LEARNING ACTIVITIES

1. Contact your local supplier of air filters and list the different kinds of filters available for this operation.
2. Instruct students to research air flow and velocity characteristics of various filter media.
3. Relate to the class the procedure to replace a filter.

PERFORMANCE OBJECTIVE V-TECS 65

LEARNING ACTIVITIES

4. Describe what to look for when inspecting for damage and wear.
5. Explain how to unlock power in proper sequence.

RESOURCES

Manufacturer's Specifications.

Swain, et al. **Power Handbook**, p. 54.

EVALUATION

Questions

1. Humidity affects the life of the filter media. (True or False)
2. The Dewpoint is where condensation starts. (True or False)
3. All filters work the same. (True or False)
4. Air flow means the speed the air moves through the filter. (True or False)

Answers

1. True
2. True
3. True (They remove unwanted contamination).
4. False (Air flow is volume; speed is velocity).

DUTY: MAINTAINING AND REPAIRING HEATING/COOLING DEVICES

PERFORMANCE OBJECTIVE V-TECS 66

TASK: Assemble and disassemble a centrifugal/axial flow fan.

CONDITIONS: A noisy or inoperative blower/fan unit, specifications, replacement parts, lubricants, and the following tools and equipment:

Grease gun
Mechanic's tool box (hand tools)
Oil can
Personal safety equipment
Steel brush
Wiping rags
Manufacturer's Specifications.

STANDARD: When completed, the fan will have been disassembled and assembled, inspected, defective parts repaired or replaced, and will operate in accordance with manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Dismantle to expose fan/blower unit as necessary.
3. Remove guards, shrouds, mesh covers. Clean/inspect for wear and damage. Obtain replacements if necessary.
4. Disconnect drive unit.
   a. Direct Drive. Disconnect coupling. Inspect for wear and damage. Replace if necessary.
   b. Indirect Drive. Remove belt. Inspect for wear and damage.
5. Disconnect controls from fan/blower unit.
6. Disconnect fan/blower unit from duct work as necessary.
7. Remove fan/blower unit from duct work as necessary.
8. Loosen fan/blower unit bearing housings. Remove covers and seals. Clean/inspect for wear and damage. Replace if necessary.
9. Remove impeller (fan blade assembly). Clean/inspect for wear and damage. Straighten/replace fan blades as necessary. Check for balance.
10. Clean/inspect shaft for wear and damage. Straighten/replace as necessary.
11. Remove/clean/inspect filters. Replace as necessary.
12. Clean/inspect fan/blower housing/duct work for wear and damage. Repair/replace as necessary.
13. Re-install/align impeller assembly. Lubricate as necessary.
14. Align/tighten bearings.
15. Remount fan/blower assembly unit as necessary.
16. Reconnect duct work as necessary.
17. Reconnect controls.

PERFORMANCE OBJECTIVE V-TECS 66

PERFORMANCE GUIDE Continued

18. Connect/align drive unit.
19. Re-install filter.
20. Unlock/check operation according to manufacturer's specifications.

ENABLING OBJECTIVES

Read and interpret manufacturer's specifications.

Use hand tools.

LEARNING ACTIVITIES

1. Describe proper lock out procedure for power supply.
2. Discuss the reasons for guards, shrouds, and covers.
3. Demonstrate the alignment procedure for direct drive couplings.
4. Explain the need for matched belts on belt drives.
5. Instruct students to research lubrications and report on the correct one for this application.

RESOURCES

OSHA Standards.

EVALUATION

Questions

1. It is necessry to lock out power before working on a machine.
   (True or False)
2. Matched belts give better traction on multigroove sheaves than unmatched belts.
   (True or False)
3. Any lubrication will work on a fan.
   (True or False)
4. Misalignment of direct drive couplings causes excessive wear of components.
   (True or False

Answer

1. True
2. True
3. False
4. True

MAINTAINING BOILERS

DUTY: MAINTAINING BOILERS

PERFORMANCE OBJECTIVE V-TECS 67

TASK: Replace/install pipe insulation.

CONDITIONS: A boiler pipe in need of insulation, pipe insulation, fastening clamps or tape, and the following tools and equipment:

Cutters
Hand saw
Masks
Personal safety equipment
Scaffold or ladders
Scales and rulers
Scrapers
Steel brush.

STANDARD: When completed, the insulation must cover entire pipe, be tight and secured with no sag.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Inspect existing pipe insulation for damage, wetness, and looseness.
2. Remove all sections that are water soaked, that contain loose insulation or are torn or split. CAUTION: Be cautious not to touch hot pipes. Wear protective gloves when working on pipes. Wear protective mask when working with asbestos.
3. Inspect all clamps and wrapping devices.
4. Remove all damaged sections of insulation.
5. Inspect pipe for leaks or damage. Report if necessary.
6. Select proper size and grade of new insulation.
7. Cut to proper lengths.
8. Install on boiler pipe.
9. Fasten insulation to pipe by using clamps/fasteners or tape by opening slit and forcing onto pipe.
10. Recheck fit.
11. Discard old insulation.

ENABLING OBJECTIVES

Use hand tools.

Read scales and rules.

PERFORMANCE OBJECTIVE V-TECS 67

LEARNING ACTIVITIES

1. Instruct students to research pipe insulation and report to class the different kinds available.
2. Explain the type that should be used in a boiler room and why.
3. Describe what kind of damage you might expect to find under the insulation.
4. Discuss the proper way to prepare the pipe before installing new insulation.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Why has asbestos insulation been outlawed?
2. What does the grade or class of insulation refer to?
3. All insulation will do the same job.
   (True or False)

Answers

1. Respiratory health hazard.
2. Working temperature range.
3. False

DUTY: MAINTAINING BOILERS

PERFORMANCE OBJECTIVE V-TECS 68

TASK: Replace/install check valves on water feed systems.

CONDITIONS: A water feed line on a boiler system, pipe sealant or flange gaskets, check valve(s), and the following tools and equipment:

Mechanic's tool box (hand tools)
Personal safety equipment
Pipe wrenches
Scaffold or ladder
Wiping rags.

STANDARD: When completed, the check valve must operate to specifications and not leak.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Inspect check valve area for leaks or damage.
2. Isolate the faulty valve(s) by shutting off valves and bleeding adjacent lines.
3. Tag shut-off valves.
4. Remove check valve to be replaced.
5. Install new check valve in specified position.
6. Open valves.
7. Inspect for leaks and operation of check valve.
8. Remove air from line as necessary.
9. Remove tags.

ENABLING OBJECTIVE

Use hand tools.

LEARNING ACTIVITIES

1. Devise a list of the proper tools needed for this job.
2. Explain the function of a check valve.
3. Discuss with the class the reasons for tagging all shut off valves.
4. Have a piping contractor visit the class and describe the proper procedures for making corrections.
5. Describe the different pipe sealants used for threaded connections.

PERFORMANCE OBJECTIVE V-TECS 68

RESOURCES

Blankenbaker, **Modern Plumbing**, pp. 227-228.

EVALUATION

Questions

1. What is a check valve?
2. Why is it necessary to tag closed valves?
3. Why is it necessary to apply pipe dope on a screwed connection?

Answers

1. A one way flow control valve.
2. To prevent someone from opening it and causing either an accident or damage to equipment.
3. To prevent leaks.

DUTY: MAINTAINING BOILERS

PERFORMANCE OBJECTIVE V-TECS 69

TASK: Replace/install cleanout plugs.

CONDITIONS: A boiler system, sealant or gasket materials, and the following tools and equipment:

Boiler tools
Mechanic's tool box (hand tools)
Personal safety equipment
Pipe wrenches.

STANDARD: When completed, the cleanout plugs must be secure with no leaks.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out boiler power.
2. Inspect cleanout plugs for damage, corrosion or leaks.
3. Isolate the working area.
4. Remove cleanout plugs as necessary.
5. Install new cleanout plugs.
6. Pressurize system.
7. Recheck for leaks.
8. Unlock power.

ENABLING OBJECTIVES

Use handtools.

Read and interpret manufacturer's specifications.

LEARNING ACTIVITIES

1. Examine cleanouts and compare with new plugs to determine the extent of damage by corrosion.
2. Discuss laws pertaining to pressurized vessels and preventive maintenance.
3. Using manufacturer's specifications locate and identify all clean outs on the boiler.
4. Instruct students to research boiler construction and report on the reasons and location of cleanouts.

PERFORMANCE OBJECTIVE V-TECS 69

RESOURCES

Elonka. **Standard Boiler Operator's Questions and Answers,** pp. 309-328.

EVALUATION

Questions

1. On what basis are repairs allowed on boilers?
2. All repairs must be approved by an authorized inspector. (True or False)
3. What is the usual problem with handhole and manhole openings?

Questions

1. Restoring damaged parts to as near original strength as possible.
2. True - In states where inspection is mandatory.
3. Leaks.

DUTY: MAINTAINING BOILERS

PERFORMANCE OBJECTIVE V-TECS 70

TASK: Install strainer/water filter.

CONDITIONS: A boiler system containing strainer/water filters, gaskets, sealants, and the following tools and equipment:

Mechanic's tool box (hand tools)
Personal safety equipment
Pipe wrenches
Wiping rags.

STANDARD: When completed, the strainer/filter must operate according to manufacturer's specifications without leaks.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Isolate the strainer or filter from the system.
3. Bleed lines to reduce pressure.
4. Inspect old filter/strainer fittings for damage or leakage.
5. Remove filter/strainer.
6. Obtain replacement filter/strainer.
7. Apply sealant/gasket.
8. Install new filter/strainer in line.
9. Unlock power.
10. Pressurize system.
11. Check for leaks in system.
12. Check strainer/filter for correct operation.

ENABLING OBJECTIVES

Use hand tools.

Read and interpret manufacturer's specifications.

LEARNING ACTIVITIES

1. Research and discuss various types of electrical lock out techniques and necessity of individual locks for each man or the repair crew.
2. Report to class on types of filters and strainers available for boiler systems.
3. Discuss various kinds of gaskets used for strainers and when they should be used.

PERFORMANCE OBJECTIVE V-TECS 70

LEARNING ACTIVITIES

4. Check with building maintenance in regards to your boiler need for filtration.
5. Discuss the procedure to pressurize the system safely.

RESOURCES

Manufacturer's Specifications.
Standard Boiler Operators' Questions and Answers.

EVALUATION

Questions

1. Pure water is found in the natural state.
   (True or False)
2. Impurities can get into boiler feedwater.
   (True or False)
3. After replacing strainers it is necessary to prime the system before start up.
   (True or False)
4. All filters do the same job.
   (True or False)

Answers

1. False
2. True
3. True
4. False

DUTY: MAINTAINING BOILERS

PERFORMANCE OBJECTIVE V-TECS 71

TASK: Install piping and fittings.

CONDITIONS: A boiler system, pipes, fittings, gaskets or sealants, hangers, cutting oil, and the following tools and equipment:

Code for boilers
Cutoff saws
Mechanic's tool box (hand tools)
OSHA Regulations
Pipe threading equipment
Pipe wrenches
Scriber
Welding equipment
Wiping rags.

STANDARD: When completed, the pipes and fittings must not leak or sag and be in compliance with design drawings, codes and regulations.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2323-2343.

PERFORMANCE GUIDE

1. Lock out system power.
2. Shut off valves and drain pipes.
3. Select pipe and fittings as per code/regulations.
4. Measure pipe.
5. Cut pipe.
6. Prepare ends of pipe.
   a. Threaded. Thread pipe ends according to specifications.
   b. Flanged. Apply sealants. Tighten collars and bolts.
   c. CAUTION: Use specified torque ratings.
7. Support pipe/fittings with hangers.
8. Unlock power.
9. Pressurize the line(s) and check for leaks.
10. Color code or mark line(s) per OSHA regulations.

ENABLING OBJECTIVES

Read tape measures and instruction charts.

Read and interpret established codes.

PERFORMANCE OBJECTIVE V-TECS 71

LEARNING ACTIVITIES

1. Review lock out procedures.
2. Demonstrate use of cut off saws using safety rules.
3. Compile a list of all parts and fittings needed for this job.
4. Explain the function of cutting oil.
5. Discuss the safety practices to be used on this job.

RESOURCES

OSHA Regulations.

EVALUATION

Questions

1. What is a scribe?
2. Cutting oil is used for both cutting and threading pipe to what purpose?
3. The following colors are for what classification of pipes.
   a. Red
   b. Orange-yellow
   c. Green
4. Besides color bands piping should also be sign designated.
   (True or False)

Answers

1. A sharp steel instrument used to mark steel.
2. To keep cutters and dies from overheating, and to reduce friction.
3. Red - Fire equipment.
   Orange - Dangerous-materials - gas-oil-steam
   Green - safe materials - first aid.
4. True

DUTY: MAINTAINING BOILERS

PERFORMANCE OBJECTIVE V-TECS 72

TASK: Install tubing and fittings (exterior).

CONDITIONS: A boiler system, tubing, fittings, and the following tools and equipment:

Cutoff tools for tubing
Flaring tool for tubing
Lock
Mechanic's tool box (hand tools)
Personal safety equipment
Tubing bender.

STANDARD: When completed, the tubing and fittings must not leak or interfere with other pipes.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2331-2335.

PERFORMANCE GUIDE

1. Inspect existing tubing and fittings for damage or leaks.
2. Measure distances to route tubing.
3. Select tubing/fittings.
4. Cut tubing.
5. Flare tubing with flaring tool.
6. Bend to fit, using tubing bender.
7. Support tubing with hangers.
8. Lock out boiler power.
9. Install fittings.
10. Connect tubing lines in the system.
11. Unlock power.
12. Pressurize system, bleed, and check for leaks.

ENABLING OBJECTIVES

Read tape measure.

Use hand tools.

PERFORMANCE OBJECTIVE V-TECS 72

LEARNING ACTIVITIES

1. Show proficiency in the use of necessary hand tools for this job.
2. Explain why a tubing bender is necessary for a proper fitting job.
3. Demonstrate the use of a flaring tool.
4. Discuss why tubing and fittings must not interfere with other pipes.
5. Check boiler log and record all repairs by date.

RESOURCES

Blankenbaker, **Modern Plumbing.**

EVALUATION

Questions

1. As long as you have a hacksaw, tubing benders are not necessary. (True or False)
2. A flaring tool is used to hold two pieces of tubing together to be welded. (True or False)
3. A tubing cutter is the proper tool for cutting tubing. (True or False)

Answers

1. False
2. False
3. True

DUTY: MAINTAINING BOILERS

PERFORMANCE OBJECTIVE V-TECS 73

TASK: Install/replace steam traps.

CONDITIONS: A boiler system containing steam traps, gaskets, sealants, and the following tools and equipment:

Lock
Mechanic's tool box (hand tools)
Manufacturer's charts and tables
Personal safety equipment
Pipe wrenches
Special steam trap tools
Wiping rags.

STANDARD: When completed, the steam traps must be installed and tested according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Inspect steam traps for damage or leaks.
2. Lock out boiler power.
3. Isolate steam trap to be worked on by shutting off adjacent valves.
4. Remove steam trap.
5. Inspect steam trap parts for wear, damage, corrosion, deposits. Replace as necessary.
6. Consult manufacturer's specification sheet for proper operation.
7. Bench test steam trap where possible.
8. Install steam trap in line.
9. Unlock power.
10. Pressurize system by turning on valves. Bleed if necessary.
11. Check for leaks.
12. Check for operation in accordance with manufacturer's specifications.

ENABLING OBJECTIVES

Read and interpret manufacturer's charts and tables.

Use hand tools.

PERFORMANCE OBJECTIVE V-TECS 73

LEARNING ACTIVITIES

1. Explain what safety practices should be observed when working with steam lines.
2. Instruct students to research traps and diagram a steam trap explaining its function.
3. Demonstrate lockout procedures for power.
4. Show the proper installation of steam traps.
5. Explain why return lines should be the same gauge as feed side of the trap.

RESOURCES

Baumeister, Mark's, **Standard Handbook for Engineers,** pp. 8-199.

EVALUATION

Questions

1. What safety color code does a steam line come under?
2. Why should a steam return line be the same gauge pipe as the feed line?
3. Valves should be opened slowly to pressurize line gradually. (True or False)

Answers

1. Orange or yellow - dangerous material.
2. In case of a steam trap failure the return line will be pressurized the same as the feed line.
3. True

INSPECTING AND REPAIRING CRANES AND ELEVATORS

DUTY: INSPECTING AND REPAIRING CRANES AND ELEVATORS

PERFORMANCE OBJECTIVE V-TECS 74

TASK: Inspect freight and personnel elevators.

CONDITIONS: An elevator, safety checklist, elevator light bulbs, and the following tools and equipment.

Elevator repair manual
Flashlight
Grease and oil
Ladder
Personal safety equipment
Safety chains and signs.

STANDARD: When completed, lights and emergency phone or alarm must be in operative condition. Doors and gates must slide freely on tracks. All items on safety checklist must be accounted for and any deviancy reported.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Raise and lower elevator to each floor by operating "up-down" controls. Record malfunctions.
2. Inspect elevator gates and door controls for damage.
3. Inspect gates and doors/chains for damage.
4. Inspect lights for operation. Replace if necessary.
5. Check operation of emergency telephone or alarm (if exists).
6. Check fire extinguisher in elevator for certified seal.
7. Check legibility of capacity plate.
8. Check emergency lantern in elevator (if exists).
9. Inspect sprockets, pulleys, cable for wear and damage.
10. Check safety chains and "out of order" signs at each floor level for availability, wear and damage.
11. Check pits for accumulation of debris. Remove as necessary.
12. Report malfunctions and safety hazards to immediate supervisor.

ENABLING OBJECTIVES

Use hand tools.

Read and interpret repair manuals.

LEARNING ACTIVITIES

1. Explain reasons for a check list.
2. Discuss reasons for safety chains and signs.

PERFORMANCE OBJECTIVE V-TECS 74

Learning Activities Continued

3. Show the need for removal of debris from elevator pits.
4. Describe the types of wear and damage to be expected on gates and doors.
5. Dramatize the need for emergency phone or alarm in the elevator.

RESOURCES

Manufacturer's Specifications.

OSHA Standards.

EVALUATION

Questions
1. Why should debris be removed from pits?
2. Why should there be an emergency phone in the elevator?
3. Why should elevator capacity not be exceeded?

Answers
1. To prevent the danger of fire.
2. In case of break down, operator can reach assistance.
3. Safety.

DUTY: INSPECTING AND REPAIRING CRANES AND ELEVATORS

PERFORMANCE OBJECTIVE V-TECS 75

TASK: Adjust elevator doors/gates and guards.

CONDITIONS: An elevator and the following tools and equipment:

Elevator manufacturer's manual
Flashlight
Mechanic's tool box (hand tools)
Personal safety equipment
Pin punch
Pry bar.

STANDARD: When completed, doors and gates must slide freely on tracks. Doors must stop and rest flush with floor level (if applicable). All guards must be adjusted so fingers cannot get between guards and moving parts.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Open elevator doors/gates.
2. Inspect safety guards for damage, wear and security of mountings. Repair/adjust/replace as necessary.
3. Close doors/gates from inside elevator.
4. Determine where door/gate adjustment(s) is required.
   NOTE: Doors/gates should be flush with floor.
5. Open doors/gates.
6. Lock out elevator power. CAUTION: Test for "off" condition.
7. Adjust height of door/gate with bars and by:
   a. Turning adjusting nut, or
   b. Turning adjusting rod, or
   c. Loosening, shifting, tightening adjusting bracket.
8. Unlock/test adjustments by operating doors/gates.

ENABLING OBJECTIVES

Read and interpret manufacturer's manual.

Use handtools.

PERFORMANCE OBJECTIVE V-TECS 75

LEARNING ACTIVITIES

1. Describe personal safety equipment needed for this job.
2. Discuss proper use of hand tools required.
3. Using manufacturer's specifications list all adjustment points.
4. Discuss necessity of locking out power.
5. Discuss elevator inspection and load limits.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Where is the proper adjustment for doors and gates to be found?
2. What is the necessity of elevator inspection?
3. Name two pieces of personal safety equipment to be used on this job.

Answers

1. In elevator manufacturer specifications.
2. To assess wear and damage thereby preventing accidents.
3. Glasses and hard hat.

DUTY: INSPECTING AND REPAIRING CRANES AND ELEVATORS

PERFORMANCE OBJECTIVE V-TECS 76

TASK: Install/replace cable on an electric cable drum hoist.

CONDITIONS: An electric cable drum hoist, cable, and the following tools and equipment:

Bracing material/equipment
Empty cable drum
Ladder
Lock
Mechanic's tool box (hand tools)
Manufacturer's service manual
Personal safety equipment.

STANDARD: When completed, the cable must be securely fastened to the drum as per manufacturer's specifications, free of kinks and wound onto the drum uniformly so that the wraps will hug together and establish even layer(s). If the drum is grooved, the cable must wind uniformly into adjacent grooves. The fleet angle should not exceed 1½ degrees (3" in 10') for a smooth drum or 2 degrees (4" in 10') for a grooved drum.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 477-493, 1095-1101.

PERFORMANCE GUIDE

1. Lower hook unit of hoist until weight is removed from cables.
2. Brace hook unit.
3. Unwind cable from drum. Store or tie in safe location.
4. Lock out power control. CAUTION: Test for "off" condition.
5. Remove guards.
6. Inspect cable and fittings for wear, damage or corrosion.
7. Remove worn cable from pulleys. Replace as needed.
8. Inspect pulley/drum for wear or damage. (Replace worn parts).
9. Thread cable through pulleys. Clean and lubricate according to manufacturer's specifications.
10. Replace guards.
11. Attach ends of cable to drum.
12. Unlock power.
13. Take up slack in cable by engaging "Up" control.
14. Remove and store brace equipment.
15. Operate cable with no load, then light loads. NOTE: This will enable cables and strands to adjust.
16. Check fleet angle and adjust windings of cable on drum.

PERFORMANCE OBJECTIVE V-TECS 76

ENABLING OBJECTIVE

Read and interpret manufacturer's service manual.

LEARNING ACTIVITIES

1. Review the safety rules and discuss which ones will apply to this operation.
2. Discuss reasons for bracing hook unit.
3. Discuss why cable should be coiled and tied as it is removed from unit.
4. Check with manufacturer and discuss the different kinds of cable and their construction.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. There is no right way to log cable.
   (True or False)
2. Gloves should be worn when handling wire rope of any size.
   (True or False)
3. Either right or left hand twist will work equally well.
   (True or False)

Answers

1. False
2. True
3. False

DUTY: INSPECTING AND REPAIRING CRANES AND ELEVATORS

PERFORMANCE OBJECTIVE V-TECS 77

TASK: Install/replace cable on a bridge crane.

CONDITIONS: A bridge crane, cable, and the following tools and equipment:

Blocks to keep crane from moving
Bracing materials/equipment
Bridge crane service manual
Drum
Ladder
Lock
Mechanic's tool box (hand tools)
Personal safety equipment.

STANDARD: When completed, the cable must be securely fastened to the drum, free of kinks and wound onto the drum uniformly so that the wraps will hug together and establish even layer(s). If the drum is grooved, the cable must wind uniformly into adjacent grooves. The fleet angle should not exceed 1-1/2 degrees (3" in 10') for smooth drum or 2 degrees (4" in 10') for a grooved drum.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 477-493, 1095-1101.

PERFORMANCE GUIDE

1. Lower hook unit until weight is off cable.
2. Brace hook unit.
3. Unwind cable from drum. Store or tie in safe location.
4. Lock out main power control. CAUTION: Test for "off" condition.
5. Remove guards.
6. Remove cable from pulleys.
7. Inspect cable and fittings for wear, damage or corrosion. Replace if necessary.
8. Inspect pulleys/drum for wear or damage. (Replace worn parts).
9. Thread cable through pulleys. Lubricate according to service manual.
10. Replace guards.
11. Attach ends of cable to drum.
12. Unlock power.
13. Take up slack in cable by engaging "Up" control. Check winding on drum.
14. Remove and store brace equipment.
15. Operate cable with no load, then light loads. NOTE: This will enable cables and strands to adjust.
16. Check fleet angle and adjust windings of cable on drum.

PERFORMANCE OBJECTIVE V-TECS 77

ENABLING OBJECTIVES

Read and interpret manufacturer's service manual.

Measure in degrees and English standard manual.

LEARNING ACTIVITIES

1. Visit a local rigger for a demonstration of cable fastening technique.
2. Attend a safety class given by a mill with overhead cranes.
3. Explain the need for bracing the hook unit.
4. Describe the proper "Lay" of a wire rope.
5. Discuss the safety equipment that should be used on this job.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. All cables should be operated with light loads first to properly tension the separate strands.
   (True or False)
2. Twist and lay refer to the same condition in wire rope.
   (True or False)
3. Gloves should be worn when working with cable.
   (True or False)

Answers

1. True
2. True
3. True

DUTY: INSPECTING AND REPAIRING CRANES AND ELEVATORS

PERFORMANCE OBJECTIVE V-TECS 78

TASK: Inspect pulley(s) on cranes.

CONDITIONS: A crane, pulley(s), lubricant, cleaning solvent, and the following tools and equipment:

Arbor press
Bracing materials/equipment
Grease gun
Lock
Mechanic's tool box (hand tools)
Manufacturer's manual
Micrometers (outside)
Personal safety equipment
Telescoping gauge
Wiping rags.

STANDARD: When completed, pulley(s) must rotate on shaft freely, without wobble and with a clearance of .002" running fit. Pulley must operate centered between side plates without rubbing. Lubrication must reach bushing area.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lower hook unit until weight is off cables.
2. Brace hook unit.
3. Lock out crane power source. CAUTION: Test for "off" condition.
4. Remove guards.
5. Remove cables from pulleys. Store/tie cable in safe location.
6. Inspect cable for wear and damage. Replace if necessary.
7. Remove locking nuts or locking device from pulley shaft.
8. Remove pulley shaft/bearing/pin.
9. Remove pulley side plates.
10. Remove pulley.
11. Clean parts.
12. Inspect pulley shaft/bearing/pin for wear. (Replace if necessary).
13. Inspect bearings and bushings. (Replace if necessary).
14. Inspect pulley for wear or damage.
15. Replace/install pulley on shaft/bearing/pin.
16. Replace side plates.
17. Replace/install pulley/shaft assembly. Check for wobbling and rubbing. Adjust as needed.
18. Replace locking nuts or locking device on shaft.
19. Lubricate grease fittings.
20. Thread cables. Lubricate according to manufacturer's specifications.

PERFORMANCE OBJECTIVE V-TECS 78

Performance Guide Continued

21. Replace guards.
22. Unlock power.
23. Take up slack on cables by engaging "Up" control. Check winding on drum.
24. Remove and store bracing equipment.
25. Operate crane and check pulley(s) for wobbling and rubbing. Adjust as needed.

ENABLING OBJECTIVES

Read and interpret manufacturer's manual.
Use an arbor press.
Use hand tools.

LEARNING ACTIVITIES

1. Instruct students to research available pulleys for wire rope usage and report to class your findings.
2. Explain why it is necessary to clear pulleys before reinstalling them.
3. Discuss what kind of wear should be replaced.
4. Describe the causes of wobbling pulleys.
5. Explain why just any lubrication will not be sufficient for this operation.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions
1. Heavy loads roller bearings are necessary for longer life of pulleys. (True or False)
2. All parts should be cleaned before reassembling. (True or False)
3. Bad bearings cause wobble in pulleys. (True or False)
4. Preventive maintenance is a must for safe operation. (True or False)

Answers
1. True
2. True
3. True
4. True

DUTY: INSPECTING AND REPAIRING CRANES AND ELEVATORS

PERFORMANCE OBJECTIVE V-TECS 79

TASK: Install/replace mechanical safety devices on cranes.

CONDITIONS: A crane, replacement mechanical safety devices, and the following tools and equipment:

Ladder
Mechanic's tool box (hand tools)
Manufacturer's manual
Personal safety equipment.

STANDARD: When completed, safety devices must be located and secured to perform their safety function by testing. Hook safety latch must have enough tension to keep sling from climbing up and out of hook. The "raise" control must stop hook unit from raising before the unit raises and jams with other parts of crane.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out crane power.
2. Inspect "raise" safety stops for wear, damage, placement, fastening. Replace if necessary.
3. Inspect track stops for wear, damage, placement, and fastening. Replace if necessary.
4. Inspect hook safety latch for wear and damage. Replace if necessary.
5. Inspect guards for wear or damage. Replace if necessary.
6. Unlock/operate crane without load.
7. Place load on hook.
8. Operate crane with load.
9. Test drum brake as per manufacturer's specifications. Adjust or replace if necessary.

ENABLING OBJECTIVES

Read and interpret manufacturer's manual.

Use hand tools.

LEARNING ACTIVITIES

1. Review lockout procedures for power sources.
2. Describe the kind of wear or damage you might find and the cause of it.
3. Visit a steel supply house with overhead crane for a demonstration of proper operation.

PERFORMANCE OBJECTIVE V-TECS 79

LEARNING ACTIVITIES

4. Instruct students to research mechanical safety devices and discuss their function with class.
5. Explain the operation of the brake assembly.

RESOURCES

Manufacturer's Specifications.

Baumeister, Mark's, **Standard Handbook for Mechanical Engineers**, pp. 18-24.

EVALUATION

Questions
1. A lockout is used to:
    a. Prevent shock
    b. Warn others of danger
    c. Protect the workers on a down machine
    d. Secure the system for repairs
    e. All of the above
    f. None of the above.

2. How do you adjust the drum brake?
3. What is the purpose of a guard?

Answers
1. e
2. Follow the manufacturer's manual for accurate specifications.
3. To prevent personal injury from contact with moving parts.

DUTY: INSPECTING AND REPAIRING CRANES AND ELEVATORS

PERFORMANCE OBJECTIVE V-TECS 80

TASK: Inspect tracks and runway areas.

CONDITIONS: Tracks and runways, safety paint/markings, and the following tools and equipment:

Arbor press
Flashlight
Ladder
Lock
Mechanic's tool box (hand tools)
Manufacturer's specifications
OSHA regulations
Personal safety equipment
Wire and clamps.

STANDARD: When completed, tracks must be flush and without ridges where joined together. Track supports must be secure and support track as per manufacturer's specifications. Track must be straight and free from warping or twisting. Runway must be clean and free from obstacles. All nuts and bolts must be tight. Safety devices and markings must be in accordance with manufacturer's specifications and OSHA regulations.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment. CAUTION: Check for "off" condition.
2. Notify someone in charge that you will be up in the air. Place warning signs on floor as necessary.
3. Inspect runway area for obstacles and safety markings. Correct as necessary.
4. Inspect track for loose or unaligned joints. Align as required.
5. Inspect track for loose track supports. Tighten as required.
6. Inspect track for warpage or twist. Straighten or replace as required.
7. Inspect track for loose trolley stops. Tighten as required.
8. Inspect track for dust (fire hazard). Remove.
9. Inspect track for loose nuts, bolts. Tighten as required.
10. Unlock power.
11. Run crane over area and check for operation and warning signal (bell, horn, etc.).

ENABLING OBJECTIVES

Read and interpret manufacturer's specifications.

Use hand tools.

PERFORMANCE OBJECTIVE V-TECS 80

LEARNING ACTIVITIES

1. Demonstrate the procedure for power lock out using the proper equipment.
2. Describe the hazards of working up in the air and tell why someone in charge should be notified.
3. Review shop safety rules that would apply to working overhead.
4. Explain why dust can be a fire hazard on the tracks.
5. Demonstrate the hand signals for crane operation.

RESOURCES

Manufacturer's Specifications.

OSHA Regulations.

EVALUATION

Questions

1. A volt/ohm meter is used to check for power.
   (True or False)
2. A safety check list is a must when working on overhead cranes.
   (True or False)
3. Why is it necessary to check the tracks for loose or misaligned joints?

Answers

1. True
2. True
3. To prevent the crane from hanging up or jumping the track.

DUTY: INSPECTING AND REPAIRING CRANES AND ELEVATORS

PERFORMANCE OBJECTIVE V-TECS 81

TASK: Install/replace runway tracks for cranes.

CONDITIONS: A crane runway system, replacement track, support brackets, nuts, bolts, and the following tools and equipment:

Aligning bar
C-clamps
Ladder and/or elevated platform
Level
Lock
Mechanic's tool box (hand tools)
Mallet
Personal safety equipment
Safety area ropes/warning signs.

STANDARD: When completed, the track must be level to the degree that a crane supporting maximum load will not drift or roll out of control. All joints must be flush and fastened securely. Crane trolley must roll freely and smoothly. If crane is radial type, it must swing freely and smoothly.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Inspect track for wear or damage.
2. Determine track section(s) requiring installation/replacement.
3. Clear area of safety hazard obstacles.
4. Transport tools and equipment to job site.
5. Rope off area of job site. Place warning sign of overhead work being done.
6. Lock out main control of power source of crane, either electrical or air.
7. Place ladder or suitable elevated work platform in position under crane. Check for stability.
8. Move or remove trolley from track section which is being replaced/installed.
9. Install/replace track supporting brackets.
10. Attach track to supporting brackets.
11. Level track by adjusting track supporting and leveling brackets.
12. Move or replace track supporting brackets.
13. Remove ladder or work platform.
14. Unlock power.
15. Test tracks for levelness and smooth operation by operating crane without load. Adjust as necessary, then test with load.
16. Remove rope and warning signs.
17. Return tools and equipment to storage.

PERFORMANCE OBJECTIVE V-TECS 81

ENABLING OBJECTIVES

Use hand tools.

Use of knowledge on safety rules and policy.

LEARNING ACTIVITIES

1. Using manufacturer's specifications, locate track tolerances and identify them. Apply this information to determine track sections to be replaced.
2. Discuss what would be classified as a safety hazard.
3. Discuss ways to implement safety without compromising production.
4. Review lock out procedures and state their reasons.
5. List two ways to place track into position.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Roping off the work area is good safety practice.
   (True or False)
2. Ladder stability should be secured before use.
   (True or False)
3. New tracks should be level and square to existing track.
   (True or False)

Answers

1. True
2. True
3. True

DUTY: INSPECTING AND REPAIRING CRANES AND ELEVATORS

PERFORMANCE OBJECTIVE V-TECS 82

TASK: Adjust mechanical brake.

CONDITIONS: A crane with drum hoist and mechanical brake, load, and the following tools and equipment:

Ladder or work platform
Lock
Mechanic's tool box (hand tools)
Manufacturer's service manual
Personal safety equipment
Safety area ropes/warning signs

STANDARD: When completed, the brake will be adjusted to operate with load within manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Read "brake adjustment" section of manufacturer's service manual.
2. Lower hook to floor with no load on drum.
3. Lock out hoist power supply.
4. Place warning sign of overhead work being done.
5. Place ladder or elevated work platform in position under crane.
6. Remove brake guards or outer housings.
7. Adjust clearance between brake shoes and brake drum to manufacturer's specifications. NOTE: If adjustment cannot be made, replace brake.
8. Replace outer housings and guards.
9. Remove ladder/work platform.
10. Unlock power.
11. Pick up load with crane.
12. Test efficiency of brake by raising and lowering load. CAUTION: Stand clear of load while testing.
13. Repeat steps #1 - #12 as required.
14. Remove warning sign.

ENABLING OBJECTIVES

Read and interpret manufacturer's service manual.

Use hand tools.

PERFORMANCE OBJECTIVE V-TECS 82

LEARNING ACTIVITIES

1. Describe the operation of a drum hoist and mechanical brakes.
2. Discuss the need for safety ropes and warnings signs.
3. Explain the reasons for guards.
4. Discuss proper safety procedure for working on brakes.
5. Describe why there is clearance between brake and drum.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. A drum hoist and mechanical brake work separately. (True or False)
2. Hook should not be left in mid-air during repairs. (True or False)
3. There is no need for clearance between brake and drum. (True or False)

Answers

1. True
2. True
3. False

MAINTAINING TRACTORS AND TRUCKS

DUTY: MAINTAINING TRACTORS AND TRUCKS

PERFORMANCE OBJECTIVE V-TECS 83

TASK: Complete a preventive maintenance report.

CONDITIONS: A malfunctioning tractor or truck, maintenance report forms, and the following tools and equipment:

Maintenance checklists
Mechanic's tool box (hand tools)
Personal safety equipment
Specifications manual/operator's manual

STANDARD: When completed, the report should be legible and correctly identify the malfunction(s).

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Inspect area under vehicle for leaks of coolant, oils, fuel, fluids.
2. Inspect vehicle for leaks around gear boxes, housings, hydraulic reservoirs and hoses.
3. Inspect for defective lights and other safety devices.
4. Inspect for broken parts.
5. Inspect for defective tires and tire pressures.
6. Inspect ballast weights for secure mounting.
7. Inspect safety guards and shields.
8. Inspect levels of coolant, battery electrolyte and brake fluid.
9. Inspect air cleaner.
10. Inspect fuel filter.
11. Inspect distributor cap and wires.
12. Inspect spark plugs and wires.
13. Inspect belts for damage, wear and tension.
14. Inspect radiator hoses.
15. Start engine.
16. Check for air compressor buildup.
17. Check for unusual noises, vibrations, odors, leaks.
18. Check all gauges for malfunctions and defects (temperature, oil, fuel, electrical).
19. Evaluate alternator/generator and regulator output.
20. Check engine idle (air/fuel mixture).
21. Check for defective hydraulic system.
22. Drive vehicle.
23. Check for unusual noises, vibrations, odors.
24. Check for defective brakes, clutches, operation of mounted equipment.
25. Park and shut off vehicle.
26. Complete and forward reports(s).

PERFORMANCE OBJECTIVES V-TECS 83

ENABLING OBJECTIVES

Demonstrate automotive troubleshooting skills.

LEARNING ACTIVITIES

1. Discuss the importance of the preventative maintenance report.
2. Point out the need for a driver's report to enable effective diagnosis.
3. Demonstrate the checkover of a tractor or truck.
4. Show how to record findings on the report form and make appropriate explanatory comments in the space provided.
5. Engage the students in making their own reports and evaluate them for accuracy.

RESOURCES

Motor, Truck Repair Manual, 33rd. ed.

Chilton's Truck and Van Service Manual, Chilton Book Company.

EVALUATION

Questions

1. Which of the following information should be entered on the P.M. report?
   a. Unit number and make
   b. Make, model and year
   c. Serial number and make
   d. Make, model, serial number, year, and unit number.
2. A vehicle makes a squealing sound when the steering is cranked to full lock. Which of the following would be the best solution to the problem?
   a. Tighten the power steering belt until the squealing stops;
   b. Tighten the power steering belt to manufacturer's specifications, and if squealing persists replace the belt;
   c. Check and replace the power steering pump;
   d. Check the power steering system for leaks and repair as necessary.
3. The front tires of a vehicle are worn on the outside edges only. This would be an indication of which of the following:
   a. Worn tie rod ends
   b. Excessive positive camber
   c. Excessive toe out
   d. Either b or c.

Answers

1. d
2. b
3. d

DUTY: MAINTAINING TRACTORS AND TRUCKS

PERFORMANCE OBJECTIVE V-TECS 84

TASK: Replace batteries.

CONDITIONS: A vehicle with a battery needing replacement and the following tools and equipment:

End wrenches
Lift strap
Manufacturer's specifications
Non-metallic grease
Protective pad, for fender
Safety glasses etc.
Steel brush
Terminal cleaning brush
Terminal puller
Terminal spreader.

STANDARD: When completed, the battery will be replaced into the battery holder, terminals connected and coated according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Cover the fender with the protective pad.
2. Note which battery post is grounded (usually negative).
3. Loosen both terminal clamps.
4. Disconnect ground cable terminal. Use puller if necessary.
5. Disconnect positive terminal. Use puller if necessary.
6. Remove the hold-down plate or bar.
7. Attach battery lift strap.
8. Lift out the old battery. CAUTION: Do not spill electrolyte.
9. Inspect the battery cage or holder and hold-down device for damage and corrosion. Clean with steel brush, baking soda, and water. Paint with acid-proof paint.
10. Clean cable terminals with steel brush and soda/water solution.
11. Clean terminals of replacement battery.
12. Attach the battery lift strap to replacement battery.
13. Place new battery into holder. NOTE: The battery terminals should be in position to receive the cables.
14. Install hold-down plate.
15. Connect positive terminal.
16. Connect ground terminal.
17. Coat terminals and posts with non-metallic grease.

PERFORMANCE OBJECTIVE V-TECS 84

ENABLING OBJECTIVES

None

LEARNING ACTIVITIES

1. Explain the dangers associated with improper handling of wet cell batteries.
2. Discuss the proper procedures for removal and installation of wet cell batteries.
3. Demonstrate removal of a vehicle battery emphasizing proper procedures.
4. Demonstrate installation of a vehicle battery with the emphasis on proper procedure and safety.
5. Show how to do a battery voltage drop test on the starter motor and check the results.

RESOURCES

Stockel, **Auto Mechanics Fundamentals**, pp. 371-375.

EVALUATION

Questions

1. The battery electrolyte contains sulfuric acid and:
    a. Hydrogen
    b. Carbonic acid
    c. Water
    d. Ammonia.
2. The positive post of a battery may be identified usually by its:
    a. Different color metal
    b. Slightly larger size
    c. Shape
    d. Slightly smaller size.
3. Batteries give off hydrogen and oxygen gas which may cause:
    a. Explosion
    b. Irritated skin and eyes
    c. Sneezing
    d. Complete loss of electrolyte.

Answers

1. c
2. b
3. a

DUTY: MAINTAINING TRACTORS AND TRUCKS

PERFORMANCE OBJECTIVE V-TECS 85

TASK: Install/replace water pump.

CONDITIONS: A tractor/truck needing a water pump replaced, replacement water pump, gaskets, and the following tools and equipment:

Drain pan
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Tag.

STANDARD: When completed, the water pump will have been installed according to manufacturer's specifications and there will be no leaks.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Tag out tractor/truck.
2. Drain cooling system into drain pan.
3. Disconnect hoses or pipes.
4. Remove engine compartment components as needed, to facilitate removal of water pump.
5. Remove water pump.
6. Clean gasket surfaces.
7. Install water pump with new gaskets.
8. Re-install engine compartment components.
9. Connect hoses or pipes.
10. Adjust belt drives.
11. Refill cooling system.
12. Bleed system.
13. Start engine.
14. Test system for leaks.
15. Check coolant level. Refill as necessary.
16. Check for overheating.
17. Stop engine.
18. Remove tag.

ENABLING OBJECTIVES

Demonstrate basic skills working with mechanic's handtools.

PERFORMANCE OBJECTIVE V-TECS 85

LEARNING ACTIVITIES

1. Explain the importance of the water pump to the vehicle cooling system.
2. Discuss the importance of proper belt tension, clean coolant, fan and pulley balance and proper installation to good water pump service.
3. Demonstrate removal of the water pump following proper procedures.
4. Demonstrate proper installation of the water pump.
5. Show appropriate leak testing procedures.

RESOURCES

Chilton's Truck and Van Service Manual, p. 39.

Stockel, **Auto Mechanics Fundamentals**, pp. 76-91.

EVALUATION

Questions

1. The number one cause of water pump failure is:
    a. Too much belt tension
    b. Contaminants in the cooling system
    c. Failure to use a corrosion inhibitor
    d. Worn bearings.
2. The water pump causes coolant to circulate because of:
    a. Convention
    b. Positive displacement of the pump
    c. Centrifugal action created by the impeller and pump housing
    d. The turbine vanes.
3. Water pump housings are usually made of which of the following materials?
    a. Copper and brass
    b. Aluminum
    c. Cast iron
    d. Cast iron and aluminum.

Answers

1. a
2. c
3. d

DUTY: MAINTAINING TRACTORS AND TRUCKS

PERFORMANCE OBJECTIVE V-TECS NO. 86

TASK: Install/replace thermostat.

CONDITIONS: A tractor/truck needing a thermostat in cooling system, new thermostat with seal, gasket, and the following tools and equipment:

Drain pan
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Scraper
Tag.

STANDARD: When completed, the engine should operate at specified temperatures with no leaks.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Tag out tractor/truck.
2. Place drain pan.
3. Lower coolant level below thermostat housing.
4. Loosen hoses and clamps on thermostat housing.
5. Remove housing cover and gaskets.
6. Remove thermostat and seals.
7. Clean internal seating areas of housing and cover.
8. Install new thermostat seals in cover.
9. Place new gasket in thermostat housing.
10. Install thermostat.
11. Install cover.
12. Connect hoses.
13. Refill cooling system to specified level.
14. Bleed system.
15. Start engine.
16. Inspect for leaks.
17. Remove tag.

ENABLING OBJECTIVES

Demonstrate basic skills working with mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss the importance of the thermostat to the vehicle cooling system.
2. Explain the various types of thermostats and their characteristics.

Learning Activities Continued

3. Demonstrate removal of the thermostat following correct procedures.
4. Show installation of the thermostat using correct procedures.
5. Demonstrate warm up of the engine to operating temperature and checking for leaks.

RESOURCES

Stockel, **Auto Mechanics Fundamentals**, pp. 75-91.

The Pressurized Cooling System. Fre-Bar. pp. 1-5.

EVALUATION

Questions

1. In most gasoline engines temperatures below _________ are undesirable.
   a. 160°F
   b. 170°F
   c. 180°F
   d. 190°F
2. The two types of thermostats are the bellows types and the ______ type.
   a. pellet
   b. thermocouple
   c. spring
   d. diaphragm
3. If an engine runs too cold it will:
   a. Use more fuel
   b. Produce less horsepower
   c. Wear quickly
   d. All of the above.

Answers

1. c
2. a
3. d

DUTY: MAINTAINING TRACTORS AND TRUCKS

PERFORMANCE OBJECTIVE V-TECS NO. 87

TASK: Install/replace radiator/heater hoses.

CONDITIONS: A tractor/truck with defective radiator/heater hoses, sealant, coolant, replacement hoses, and the following tools and equipment:

Drain pan
Maintenance mechanic's tool box (hand tools)
Manufacturer's manual
Personal safety equipment.

STANDARD: When completed, there must be no coolant leaks when engine operates at specified temperatures.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Tag out tractor/truck.
2. Drain cooling system into drain pan.
3. Identify defective hoses.
4. Remove hose clamps.
5. Remove hose.
6. Inspect connecting points for foreign matter. Clean as necessary.
7. Install new hoses. Use new clamps where necessary.
8. Fill system with coolant to specified level.
9. Bleed heater system. Disconnect topmost heater hose at its highest point and allow coolant to flow through both disconnected points.
10. Refill to specified level.
11. Bring system to specified operating temperatures.
12. Check for leaks.
13. Remove tag.

ENABLING OBJECTIVE

Demonstrate basic skills in working with mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss the importance of hoses to the cooling system.
2. Point out that hoses are the most frequent component problem of the cooling system.
3. Demonstrate removal and replacement of hoses by following correct procedures.

PERFORMANCE OBJECTIVE V-TECS NO. 87

Learning Activities Continued

4. Demonstrate leak inspection of the cooling sytem following the hose replacement procedure.
5. Engage the students in removing and replacing hoses and check for leaks.

RESOURCES

Stockel. **Auto Mechanics Fundamentals,** pp. 75-91.

The Pressurized Cooling System. Fre-Bar, pp. 1-8.

EVALUATION

Questions

1. Cooling system hoses should be replaced if they are brittle, bulging, ________ or ________.
    a. soft or corroded
    b. collasped or cracked
    c. cut or stained
    d. all of the above
2. Hose clamps may cut hoses if they are:
    a. Seeping
    b. Corroded
    c. Overtightened
    d. Loose.
3. The most common cause of cooling system failure is:
    a. Deposit build up in the radiator core
    b. Failure of a hose component
    c. Thermostat stuck in the closed position
    d. Poor coolant maintenance.

Answers

1. b
2. c
3. b

DUTY: MAINTAINING TRACTORS AND TRUCKS

PERFORMANCE OBJECTIVE V-TECS 88

TASK: Install/replace brake shoes.

CONDITIONS: A tractor/truck with a hydraulic brake system, worn brake shoes, lubricant, cleaning solvent, new brake shoes, and the following tools and equipment:

Blocking/stands
Brake drum grinder
Brake shoe grinder (optional)
Brake spring pliers
Drum clearance gage
Drum micrometer
Mechanic's tool box (hand tools)
Manufacturer's manual
Personal safety equipment
Tag
Wheel cylinder clamps.

STANDARD: When completed, the wheels will brake evenly without side sway. The pedal free travel will be within manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Tag out tractor/truck.
2. Place wheel blocks to prevent movement of vehicle.
3. Raise axle(s) needing brake shoes. CAUTION: Place on blocks or stands.
4. Remove wheel(s) and drums.
5. Remove brake shoes.
6. Lubricate adjuster assembly.
7. Inspect backing plates for wear or damage. Clean and lubricate.
8. Inspect brake drum(s) for wear and damage. Check for oversize, taper, eccentricity with drum micrometer. Replace, turn, or grind to specifications not to exceed .060" oversize. NOTE: Diameters of drums on same axle should be within .010."
9. Grind new brake shoes to fit drum diameters. CAUTION: Asbestos is dangerous to health.
10. Install brake shoes.
11. Adjust brake shoes. Using a drum-to-shoe clearance gage, set the gage at the inner diameter of the drum and lock at this setting. Place gage horizontally over the installed brake shoes. With the star wheel, expand the shoes until they touch the gage.
12. Install replacement hydraulic slave cylinders if necessary.
13. Install drums and wheels.
14. Lower axle(s).

PERFORMANCE OBJECTIVE V-TECS 88

Performance Guide Continued

15. Bleed lines. Check manufacturer's manual. Open valve, hold-down brake pedal, then close valve, and release brake pedal. Repeat as necessary for each wheel.
16. Check/adjust brake pedal operation to manufacturer's specifications.
17. Check fluid level.
18. "Road" test.
19. Remove tag.

ENABLING OBJECTIVE

Demonstrate basic skills working with mechanic's handtools.

LEARNING ACTIVITIES

1. Discuss the importance of the hydraulic braking system, its components and their functions.
2. Explain the various types of hydraulic truck brakes and their characteristics.
3. Demonstrate the overhaul of one brake assembly and explain the steps of the procedure.
4. Engage the students in overhauling the remaining brake assemblies on the vehicle and check all work for accuracy.
5. Show how to bleed and adjust the brake system and test.

RESOURCES

Motor Truck Repair Manual, 33rd ed., pp. 590-599.

Chilton's Truck and Van Service Manual, pp. 16-25.

EVALUATION

Questions

1. The bleeding procedure is used on a brake system to:
    a. Fill the system with fresh fluid.
    b. Eliminate air bubbles trapped in the system.
    c. Equalize pressures on the booster diaphragm.
    d. Allow the wheel cylinders to work more efficiently.
2. Truck hydraulic brakes are often self adjusting but in addition have slots in the brake backing plate to:
    a. Vent the brake assembly and assist in cooling.
    b. Provide access to the brake bleeders.
    c. Provide for manual adjustment and lining inspection.
    d. Provide for convenient disassembly of the brake mechanism.

PERFORMANCE OBJECTIVE V-TECS 88

Evaluation Continued

3. Brake adjusters are either of the star type or:
   a. Eccentric type
   b. Spragg types
   c. Collett type
   d. Piston type.

Answers

1. b
2. c
3. a

DUTY: MAINTAINING TRACTORS AND TRUCKS

PERFORMANCE OBJECTIVE V-TECS 89

TASK: Install/replace master cylinder.

CONDITIONS: A vehicle with a defective master cylinder in braking system, cleaning solvent, brake fluid, and the following tools and equipment:

Drain pan
Helper
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Tag.

STANDARD: When completed, the braking system will operate according to manufacturer's specifications with no leaks or air in the braking system.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Remove ignition keys/tag out vehicle.
2. Drain brake fluid from master cylinder.
3. Disconnect brake pedal from the master cylinder push rod.
4. Disconnect the hydraulic lines from the master cylinder. Plug or cap ends of lines.
5. Loosen mounting bolts and remove old cylinder.
6. Bench bleed new cylinder.
7. Install new master cylinder. Align the push rod with the pedal linkage. Finger tighten mounting bolts.
8. Connect the brake lines.
9. Tighten the cylinder mountings.
10. Connect the master cylinder push rod to the brake pedal. Adjust free play as necessary.
11. Fill to specified level.
12. Bleed lines. Check manufacturer's manual. Open valve, hold-down brake pedal, then close valve, and release brake pedal. Repeat as necessary for each wheel.
13. Tighten connections.
14. Refill the master cylinder reservoirs.
15. Bleed system.
16. Road test.
17. Check for leaks.
18. Refill as necessary.
19. Remove tag.

PERFORMANCE OBJECTIVE V-TECS 89

ENABLING OBJECTIVES

Demonstrate basic skills working with mechanic's handtools.

LEARNING ACTIVITIES

1. Explain the characteristics of single and dual chamber master cylinders.
2. Describe the function of brake boosters.
3. Demonstrate removal of the master cylinder following correct procedures.
4. Show installation of the master cylinder observing correct procedures.
5. Demonstrate how to bleed the master cylinder, road test and check for leaks.

RESOURCES

Chilton's Truck and Van Service Manual, Chilton Book Co., pp. 685-752.

Motor Truck Repair Manual, pp. 632-639.

EVALUATION

Questions

1. The most effective method of brake bleeding is by the:
   a. Vacuum bleeder method
   b. Pressure bleeder method
   c. Jar and tube method
   d. Manual method.
2. Pressure is developed in the master cylinder by pressure on a:
   a. Diaphragm
   b. Booster
   c. Hydraulic piston
   d. Spring.
3. The device that allows fluid to flow back to the reservoir on the return stroke of the master cylinder is the:
   a. Breather port
   b. Check valve
   c. Compensating port
   d. Primary cup.

Answers

1. b
2. c
3. c

PERFORMING ELECTRICAL OPERATIONS

DUTY: PERFORMING ELECTRICAL OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 90

TASK: Remove/replace fuses.

CONDITIONS: An electrical fuse box, replacement fuse strips, and the following tools and equipment:

Electrical code
Electrical test equipment (continuity tester, voltmeter, volt-ohm meter)
Fuse puller
Lock
Personal protective safety equipment
Screw drivers.

STANDARD: When completed, the fuse must be the specified amperage and securely installed according to the electrical code.

SOURCE OF STANDARD:
Wisconsin Writing Team.

Jansen. **Developing Troubleshooting Skills,** pp. 129-133.

Brumbaugh. **Heating, Ventilating and Air Conditioning,** Library, vol. 2.

PERFORMANCE GUIDE

1. Lock out equipment power source.
2. Locate faulty fuse with V.O.M.
3. Remove faulty fuse, using fuse puller.
4. Connect lamp or continuity tester.
5. Troubleshoot circuit until fault is determined.
6. Correct fault.
7. Inspect circuit for cause of fault.
8. Correct cause of fault.
9. Select replacement fuse.
    a. Complete fuse, or
    b. Fuse strip, if replacement type.
10. Install new fuse in box.
11. Unlock/turn on power and test operation.

ENABLING OBJECTIVES

Use electrical test equipment (Continuity Tester, V.O. Meter).
Fuse Puller.
Use personal protective safety equipment.
Use hand tools, screwdriver, wrenches.

PERFORMANCE OBJECTIVE V-TECS 90

LEARNING ACTIVITIES

1. Identify electrical test equipment.
2. Use electrical test equipment to:
   a. Demonstrate fuse is faulty
   b. Check circuit for fault.
3. Discuss cause of fault.
4. Read National Electrical Code pages 70-71(c) and identify the fuse rating.
5. Discuss the steps necessary to comply with code to select replacement.

RESOURCES

National Electrical Code, 1975, pp. 70-71, Item C.

EVALUATION

Questions
1. When checking faulty fuse for continuity the best meter scale to use would be.
2. To remove/replace fuse, use what tool?
3. When working with electrical circuits is it safe to work on energized equipment?
   (True or False)

Answers
1. Any resistance scale, should read infinity.
2. Select fuse puller.
3. False

DUTY: PERFORMING ELECTRICAL OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 91

TASK: Test and replace faulty electrical control components.

CONDITIONS: An electrical system, replacement electrical components and the following tools and equipment:

Circuit diagrams/blueprints
Lock
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Wire stripper.

STANDARD: When completed, the electrical control components must be mechanically secure and operate within manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen, **Developing Troubleshooting Skills,** pp. 133-144.

PERFORMANCE GUIDE

1. Shut off and lock out machine power.
2. Test circuit.
3. Remove part for bench testing, if necessary.
4. Replace part, if available.
5. Unlock/start machine/system.
6. Test for specified readings.
7. Adjust components in old part, if necessary.
8. Remove faulty component(s).
9. Recheck component calibrations.
10. Test for specified readings.

ENABLING OBJECTIVES

Use electrical test equipment (V.O. Meter).
Identify components.
Use handtools, screwdriver, wirestripper.
Read diagrams, blueprints.

LEARNING ACTIVITIES

1. Have student identify electrical test equipment to be used.
2. After having read system blue prints, have student identify the components.

PERFORMANCE OBJECTIVE V-TECS 91

Learning Activities Continued

3. Using test equipment, have student show component to be faulty.
4. Selecting proper handtool have the student secure component mechanically.
5. Read manufacturer's manual and check to see if component operates within specifications.

RESOURCES

Manufacturer's Manual.

Electrical System Blueprints.

EVALUATION

Questions

1. What is the best tool to use to remove insulation from wire?
2. What is the primary rule for working on electrical circuits?
3. In order to identify a component what would you need to understand?
4. To test a faulty component, good quality test equipment should be used, such as?

Answers

1. Wirestripper
2. Deenergize and lock out
3. Diagrams of blueprints
4. Volt-ohm-meter

Practical Application

Student will perform electrical operations to include testing and replacing faulty electrical control components. Change rotation of three phase electric motor. Replace faulty electric cords and wires. Lubricate electric motors.

Method of Evaluation

Use Checklist Performance Objective 91 to determine if the assignment was completed with at least 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 91

PERFORMANCE TEST FOR TESTING AND REPLACING FAULTY ELECTRICAL CONTROL COMPONENTS

Student's Name ____________________ Date ____________________

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor, items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the step by step process.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Were all safety percautions followed?	________	________
2. Were reference manuals used?	________	________
3. Did the student use proper tools?	________	________
4. Were the tools used correctly?	________	________
5. If power tools used, was safety checked?	________	________
6. Did student's conduct meet standards?	________	________
7. Did student dress for job requirements?	________	________
8. Did student show interest in job?	________	________
9. Was the task performed without damage?	________	________
10. Did student check for accuracy?	________	________
11. Did student check energized circuits?	________	________
12. Did student use lock and tag out?	________	________
13. Did student use good housekeeping?	________	________
14. Did student work with minimum supervision?	________	________
15. Was student's work performed to standard?	________	________
16. Was student careful with materials?	________	________
17. Did student show concern for others?	________	________
18. Did student correctly use blueprints?	________	________
19. Were all joints made correctly?	________	________
20. Was specified lubricant used?	________	________

PERFORMANCE OBJECTIVE V-TECS 91

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
21. Did student use "The Equal to Rule" of electrical insulation of connections (either or better than original insulation)?	____	____
22. Did student's maintenance procedure correct problem?	____	____
23. Did student complete task?	____	____
24. Was the completion time met?	____	____

Approved Yes ___ No ___

Evaluator's Signature ____________________ Date ____________________

DUTY: PERFORMING ELECTRICAL OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 92

TASK: Change rotation of three-phase electric motor.

CONDITIONS: An electric three-phase motor (480 A.C. or less) and the following tools and equipment:

Electric circuit tester (continuity, voltage, VOM)
Electrical code manual
Lock
Manufacturer's manual
Personal safety equipment
Screw drivers/wrenches
Tag
Wiping rags.

STANDARD: When completed, the motor must operate smoothly and rotate in reverse direction.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Anderson, **Electric Motors**, pp. 303-304.

PERFORMANCE GUIDE

1. Turn off/lock out or tag equipment power.
2. Clean area around motor plate.
3. Remove motor plate/junction box cover.
4. Change wires as specified.
5. Tighten wires.
6. Refasten motor plate/junction box cover.
7. Unlock/turn on power.
8. Check rotation.
9. Remove lock/tag on motor.

ENABLING OBJECTIVES

Use electrical test equipment (V.O. Meter).
Use handtools, screwdriver, wrenches.
Use manufacturer's manual.

LEARNING ACTIVITIES

1. Have students identify electrical test equipment to be used.
2. Read manufacturer's manual and identify components.
3. Read motor wiring diagram and identify wires.

PERFORMANCE OBJECTIVE V-TECS 92

Learning Activities Continued

4. Select wires to change in accordance with motor wiring diagram.
5. After proper insulation, energize to show rotation changed.

RESOURCES

Manufacturer's Manual.

Motor Wiring Diagram on Motor Plate.

EVALUATION

Questions

1. How are the wires on a three phase motor identified?
2. Where do you find motor connection diagram?
3. Changing any two phases reverses the motor. (True or False)
4. Should motor be reversed while running?

Answers

1. LI, L2, L3, or A, B, C.
2. On motor name plate or inside connection box (cat head).
3. True
4. Definitely not.

Practical Application

Refer to Checklist Performance Objective 92. Change rotation of three-phase electric motor.

Method of Evaluation

Use Checklist Performance Objective 92 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST PERFORMANCE OBJECTIVE V-TECS 92

PERFORMANCE TEST FOR CHANGING ROTATION OF THREE-PHASE ELECTRIC MOTOR

Student's Name ____________________ Date ____________________

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step, using the Performance Guide provided by instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to the checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Were all safety precautions followed?	______	______
2. Were reference manuals used?	______	______
3. Did the student use proper tools?	______	______
4. Were the tools used correctly?	______	______
5. If power tools used, was safety checked?	______	______
6. Did student's conduct meet standards?	______	______
7. Did student dress for job requirements?	______	______
8. Did student show interest in job?	______	______
9. Was the task performed without damage?	______	______
10. Did student check for accuracy?	______	______
11. Did student check energized circuits?	______	______
12. Did student use lock and tag out?	______	______
13. Did student use good housekeeping?	______	______
14. Did student work with minimum supervision?	______	______
15. Was student's work performed to standards?	______	______
16. Was student careful with materials?	______	______
17. Did student show concern for others?	______	______
18. Did student correctly use blueprints?	______	______
19. Were all joints made correctly?	______	______
20. Was specified lubricant used?		
21. Did student use "The Equal To Rule" of electrical insulation of connections (equal or better than original insulation)?	______	______

PERFORMANCE OBJECTIVE V-TECS 92

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
22.	Did student's maintenance procedure correct problem?	______	______
23.	Did student complete task?	______	______
24.	Was the completion time met?	______	______

Approved Yes ___ No ___

Evaluator's Signature Date

DUTY: PERFORMING ELECTRICAL OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 93

TASK: Replace faulty electrical cords and plugs.

CONDITIONS: An electrically operated machine/device with faulty electrical cords and plugs, replacement cords and plugs, and the following tools and equipment:

Continuity tester
Electrical code
Lock
Mechanic's tool box (hand tools)
Personal safety equipment
Wire cutters
Wire strippers.

STANDARD: When completed, the cords and plugs will be of specified size(s), securely connected, and insulated according to the electrical code, and will not arc or blow a fuse when plugged into specified circuit.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Turn off/lock out machine power.
2. Inspect cord and plug for any cause of failure.
3. Select replacement cord and cut to length.
4. Remove faulty cord(s) from machine/device.
5. Remove plug from cord.
6. Determine cause of faulty cord/plug.
7. Correct cause of fault.
8. Install plug on new cord.
9. Install new cord on machine/device.
10. Test for correct polarity with continuity tester.
11. Plug in machine/device.
12. Unlock/turn on power.
13. Test operation of machine/device.

ENABLING OBJECTIVES:

Use electrical test equipment (V.O. Meter).
Use handtools, wire strippers.

PERFORMANCE OBJECTIVE V-TECS 93

LEARNING ACTIVITIES

1. Have student identify electrical test equipment to be used.
2. Read pages 70-229, Item 400-3, of National Electric code before replacing faulty components.
3. Have student to replace faulty components with secure connections.
4. Student will provide proper insulating technique, in accordance with, "The Equal To Rule."
5. Use electrical test equipment, have student show cause of fault.

RESOURCES

National Electric Code, pp. 70-229, Item 400-3.

EVALUATION

Questions

1. To identify faulty electrical cord you would use a:
    a. V.O.M.
    b. Ground clamp
    c. Ampmeter.
2. A three wire cord has a ground wire for?
3. What does, "Insulated according to the Electrical Code" mean?
4. When plugging in electrical cords you should be careful not to?

Answers

1. a
2. Personal and equipment safety.
3. "Equal To" or "Better Than" original insulation.
4. Touch naked connectors.

Practical Application

Refer to Checklist Performance Objective 93. Replace faulty electrical cords and plugs.

Method of Evaluation

Use Checklist Performance Objective 93 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS NO. 93

PERFORMANCE TEST FOR REPLACING FAULTY ELECTRICAL CORDS AND PLUGS

Student's Name Date

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Were all safety precautions followed?		
2.	Were reference manuals used?		
3.	Did the student use proper tools?		
4.	Were the tools used correctly?		
5.	If power tools used, was safety checked?		
6.	Did student's conduct meet standards?		
7.	Did student dress for job requirements?		
8.	Did student show interest in job?		
9.	Was the task performed without damage?		
10.	Did student check for accuracy?		
11.	Did student check energized circuits?		
12.	Did student use lock and tag out?		
13.	Did student use good housekeeping?		
14.	Did student work with minimum supervision?		
15.	Was student's work performed to standards?		
16.	Was student careful with materials?		
17.	Did student show concern for others?		
18.	Did student correctly use blueprints?		
19.	Were all joints made correctly?		
20.	Was specified lubricant used?		
21.	Did student use "The Equal To Rule" of electrical insulation of connections (equal or better than original insulation)?		
22.	Did student's maintenance procedure correct problem?		
23.	Did student complete task?		
24.	Was the completion time met?		

Approved by Yes ____ No ____

Evaluator's Signature Date

DUTY: PERFORMING ELECTRICAL OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 94

TASK: Lubricate electric motors.

CONDITIONS: An electric motor, lubricants, and the following tools and equipment:

Grease gun
Lock
Manufacturer's manuals
Oil can
Personal safety equipment
Wiping rags.

STANDARD: When completed, the motor will operate smoothly without squeal or excessive lubricant according to manufacturer's manual.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2373-2374.

PERFORMANCE GUIDE

1. Lock out/turn off motor, if necessary.
2. Consult manufacturer's specification sheets.
3. Select lubricant.
4. Wipe off fittings.
5. Lubricate.
6. Wipe off excess lubricant.
7. Unlock/run motor for a short time, if necessary.
   NOTE: Disconnect from driven element, if necessary.
8. Inspect motor for lubricant leakage.

ENABLING OBJECTIVES

Use grease gun or oil can.
Use manufacturer's manual.
Use wiping rags.

LEARNING ACTIVITIES

1. Read manufacturer's manual and have student identify appropriate oil or grease.
2. Explain the importance of correct lubricant selection.

PERFORMANCE OBJECTIVE V-TECS 94

Learning Activities Continued

3. Show how to establish amount of lubricant.
4. Demonstrate how to apply good housekeeping practices.
5. Explain the values of good safety attitudes, good safety equipment.

RESOURCES

Manufacturer's Manual.

EVALUATION

Questions

1. Is it necessary to turn off motor before lubricating?
    a. Yes
    b. No
    c. Somtimes
    d. If leaking.
2. Should you use oil or grease to lubricate a motor?
3. Good housekeeping equipment always includes?

Answers

1. c
2. Whatever manufacturer recommends.
3. Wiping rags.

Practical Application

Refer to the Checklist Performance Objective 94. Lubricate electric motors.

Method of Evaluation

Use Checklist Performance Objective 94 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 94

PERFORMANCE TEST FOR LUBRICATING ELECTRIC MOTORS

Student's Name Date

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Were all safety precautions followed?		
2. Were reference manuals used?		
3. Did the student use proper tools?		
4. Were the tools used correctly?		
5. If power tools used, was safety checked?		
6. Did student's conduct meet standards?		
7. Did student dress for job requirements?		
8. Did student show interest in job?		
9. Was the task performed without damage?		
10. Did student check for accuracy?		
11. Did student check energized circuits?		
12. Did student use lock and tag out?		
13. Did student use good housekeeping?		
14. Did student work with minimum supervision?		
15. Was student's work performed to standards?		
16. Was student careful with materials?		
17. Did student show concern for others?		
18. Did student correctly use blueprints?		
19. Were all joints made correctly?		
20. Was specified lubricant used?		
21. Did student use "The Equal To Rule" of electrical insulation of connections (equal or better than original insulation)?		
22. Did student's maintenance procedure correct problem?		

ITEMS TO BE EVALUATED	Satifactory	Unsatisfactory
23. Did student complete task?	______	______
24. Was the completion time met?	______	______
25. Item of special interest supplied by instructor.	______	______

Approved Yes ___ No ___

Evaluator's Signature Date

DUTY: PERFORMING ELECTRICAL OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 95

TASK: Install/replace electric motor.

CONDITIONS: Machinery containing a faulty electric motor, replacement motor, and the following tools and equipment:

Chain
Dial indicator
Electrical code
Lifting device
Lock
Mechanic's tool box (hand tools)
Manufacturer's manuals
Personal safety equipment
Shim stock
Straightedge/wire
Wiping rags.

STANDARD: When completed, the electric motor will deliver full and uniform power without vibration, squealing, binding, rubbing or overheating in accordance with manufacturer's specifications, electrical code.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2348-2374.

PERFORMANCE GUIDE

1. Turn off/lock out equipment power.
2. Remove safety guards, if necessary.
3. Disconnect wires to motor.
4. Remove old motor.
5. Inspect motor base unit for fit. Adapt as necessary.
6. Inspect motor drive coupling for shaft fit. Replace as necessary.
7. Set motor on base unit.
8. Align coupling vertically with dial indicator.
9. Align coupling horizontally with dial indicator. Shim as necessary.
10. Install coupling.
11. Tighten all nuts and bolts.
12. Make electrical connections.
13. Replace safety guards, if necessary.
14. Unlock/turn on power.
15. Test run motor check for vibration or noise.

PERFORMANCE OBJECTIVE V-TECS 95

ENABLING OBJECTIVES

Use electrical test equipment.
Use handtools.
Use alignment instruments.
Use lifting device, hoist, rigging.

LEARNING ACTIVITIES

1. Having secured lifting device, have students explain proper procedure for lifting.
2. Have student identify rigging components.
3. Explain the procedure for disconnecting motor.
    (a) Electrical wiring
    (b) Mechanical coupling
4. Demonstrate alignment procedure using proper instruments.
5. Explain safety considerations when moving heavy objects.

RESOURCES

Manufacturer's Manual

Diagram of Motor Wiring on Motor Plate

EVALUATION

Questions

1. Before disconnecting motor always lock out power source.
    a. Yes
    b. No
    c. Inform supervisor.
    d. Call power company.
2. The alignment device used to set motor square is called a ________.
3. If motor squeals and vibrates on start-up, what should you do?
4. How can you tell if motor is at full or uniform power?

Answers

1. a
2. Dial indicator
3. Check alignment procedure.
4. Check amperage rating on name plate.

Practical Application

Refer to Checklist Performance Objective 95. Install and/or replace an electric motor.

PERFORMANCE OBJECTIVE V-TECS 95

Method of Evaluation

Use Checklist Performance Objective 95 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 95

PERFORMANCE TEST FOR INSTALLING/REPLACING AN ELECTRIC MOTOR

Student's Name Date

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Were all safety precautions followed?		
2.	Were reference manuals used?		
3.	Did the student use proper tools?		
4.	Were the tools used correctly?		
5.	If power tools used, was safety checked?		
6.	Did student's conduct meet standards?		
7.	Did student dress for job requirements?		
8.	Did student show interest in job?		
9.	Was the task performed without damage?		
10.	Did student check for accuracy?		
11.	Did student check energized circuits?		
12.	Did student use lock and tag out?		
13.	Did student use good housekeeping?		
14.	Did student work with minimum supervision?		
15.	Was student's work performed to standards?		
16.	Was student careful with materials?		
17.	Did student show concern for others?		
18.	Did student correctly use blueprints?		
19.	Were all joints made correctly?		
20.	Was specified lubricant used?		
21.	Did student use "The Equal To Rule" of electrical insulation of connections (equal or better than original insulation)?		
22.	Did student's maintenance procedure correct problem?		
23.	Did student complete task?		
24.	Was the completion time met?		

Approved: Yes ____ No ____

Evaluator's Signature Date

DUTY: PERFORMING ELECTRICAL OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 96

TASK: Clean electric motor.

CONDITIONS: An electric motor needing cleaning, solvents and cleaners, and the following tools and equipment:

Locks
Mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Wiping rags.

STANDARD: When completed, motor will be clean and will operate smoothly without vibration or squealing according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook,** 21st ed., pp. 2373-2374.

PERFORMANCE GUIDE

1. Turn off/lock out motor power.
2. Remove motor first.
3. Take to clean work area.
4. Remove bolts and nuts from housing of motor.
5. Disassemble motor housing.
6. Clean off all dirt and dust with solvents.
7. Inspect motor for damaged parts. Replace or record/report as necessary.
8. Reasssemble motor housing.
9. Re-install motor.
10. Unlock/turn on power.
11. Check rotation of motor.

ENABLING OBJECTIVES

Use hand tools.
Use manuals.
Use cleaning solvents.
Use personal protective equipment.

PERFORMANCE OBJECTIVE V-TECS 96

LEARNING ACTIVITIES

1. Read manufacturer's manual to select type of solvent.
2. Explain disassembly procedure with regard to safety.
3. Have student to demonstrate cleaning procedure.
4. Student will explain good housekeeping practices.
5. Have student:
    a. Write inspection record.
    b. Report damaged parts.

RESOURCES

Manufacturer's Manual.

EVALUATION

Questions

1. Before beginning to clean motor first you would:
    a. Lock out power source.
    b. Disconnect wires.
2. To clean motor parts you should use:
    a. Gasoline
    b. Kersosene
    c. Solvent
    d. Water.
3. Why should care be taken to identify line wires so as to replace them correctly?

Answers

1. a
2. c
3. To insure rotation is the same.

Practical Application

Refer to Checklist Performance Objective 96. Clean an electric motor.

Method of Evaluation

Use Checklist Performance Objective 96 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 96

PERFORMANCE TEST FOR CLEANING AN ELECTRIC MOTOR

Student's Name Date

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Were all safety precautions followed?		
2.	Were reference manuals used?		
3.	Did the student use proper tools?		
4.	Were the tools used correctly?		
5.	If power tools used, was safety checked?		
6.	Did student's conduct meet standards?		
7.	Did student dress for job requirements?		
8.	Did student show interest in job?		
9.	Was the task performed without damage?		
10.	Did student check for accuracy?		
11.	Did student check energized circuits?		
12.	Did student use lock and tag out?		
13.	Did student use good housekeeping?		
14.	Did student work with minimum supervision?		
15.	Was student's work performed to standards?		
16.	Was student careful with materials?		
17.	Did student show concern for others?		
18.	Did student correctly use blueprints?		
19.	Were all joints made correctly?		
20.	Was specified lubricant used?		
21.	Did student use "The Equal To Rule" of electrical insulation of connections (equal or better than original insulation)?		
22.	Did student's maintenance procedure correct problem?		

PERFORMANCE OBJECTIVE V-TECS 96

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
23.	Did student complete task?	________	________
24.	Was the completion time met?	________	________
25.	Items of special interest supplied by instructor.	________	________

Approved: Yes ____ No ____

Evaluator's Signature Date

PERFORMING WELDING OPERATIONS

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 97

TASK: Braze ferrous/non-ferrous metals with gas equipment.

CONDITIONS: Ferrous/nonferrous metal workpieces, a work order to braze them to specifications, flux, brazing rod, and the following tools and equipment:

Abrasive
Apron
Clamps
Oxyacetylene welding equipment
Personal safety equipment
Soapstone or chalk
Steel brush
Tongs
Welding goggles.

STANDARD: When completed the brazed joints must have uniform beads and bond with smooth even puddles without holes, crates or undercut.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed. pp. 2198-2204.

PERFORMANCE GUIDE

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Prepare metal for brazing by cleaning, grinding, positioning.
5. Select torch tip, filler rod, brazing flux.
6. Turn on/light and adjust torch to neutral or slight oxidizing flame.
7. Heat joint and filler rod and apply flux.
8. Tack joint on each end.
9. Check alignment.
10. Tin joint and braze.
11. Shut off equipment and bleed lines.
12. Clean and cool workpiece(s).
13. Check braze.

ENABLING OBJECTIVE

Demonstrate oxy-gas safety practices.

PERFORMANCE OBJECTIVE V-TECS 97

LEARNING ACTIVITIES

1. Explain the advantages of braze welding.
2. Identify the limitations of braze welding.
3. Emphasize the importance of proper flux and rod selection for the materials being brazed, as well as correct gas pressures.
4. Demonstrate tinning of the joint and how to tack weld it.
5. Demonstrate vertical and horizontal braze welding.

RESOURCES

Pender. **Welding**, pp. 81-90

Giachino, et al. **Welding Skills and Practices**, pp. 297-311.

EVALUATION

Questions

1. What kind of flame is recommended for oxyacetylene braze welding?
   a. Carburizing
   b. Neutral
   c. Oxidizing
   d. Wide.
2. The greatest danger in braze welding is:
   a. Toxic fumes
   b. Flashback
   c. Burns
   d. Eye damage.
3. Bronze welding should not be used when subject to temperatures in excess of:
   a. 1200 degrees F.
   b. 750 degrees F.
   c. 500 degrees F.
   d. 900 degrees F.

Answers

1. b
2. a
3. c

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 98

TASK: Flame cut metal with gas equipment.

CONDITIONS: Ferrous metal workpieces varying in thickness from 1/4" (6.3mm) to 1 1/4" (31.5mm), a work order specifying straight, angle, slot, bevel, circle and piercing cuts, and the following tools and equipment:

Apron
Center punch
Fire watch
Hammer
Oxyacetyline cutting equipment
Personal safety equipment
Rule
Soapstone or chalk
Steel brush
Tongs
Welding goggles.

STANDARD: When completed, the cuts must be within a tolerance of American Welding Society criteria for cut surfaces.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2227-2228.

PERFORMANCE GUIDE

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Post a fire watch if necessary.
5. Determine grade of steel by:
    a. Spark stream, or
    b. Code number.
6. Lay out cuts.
7. Select torch tip according to equipment manufacturer's specifications.
8. Open tank valves and adjust pressure to specified readings on regulators according to manufacturer's specifications.
9. Turn on/light and adjust torch to neutral flame with cutting oxygen.
10. Cut metal to specifications.
11. Close tank valves and bleed lines.
12. Cool metal.
13. Check cuts and dimensions.

PERFORMANCE OBJECTIVE V-TECS 98

ENABLING OBJECTIVES

Demonstrate proper safety procedures with oxy-gas cutting equipment.

LEARNING ACTIVITIES

1. Explain the various types of oxy-gas equipment used in cutting operations.
2. Point out the importance of proper tip selection and gas pressures for the thickness of the material being cut.
3. Emphasize the importance of conserving material and the rule of not starting a heavy cut unless you are sure you can complete it.
4. Show the proper flames needed to cut cast iron or steel and describe the specialized equipment needed to cut nonferrous metals.
5. Demonstrate straight, slot, bevel and piercing cuts.

RESOURCES

Giachino, et al. **Welding Skills and Practices**, pp. 336-342.

Pender, **Welding**, pp. 66-80.

EVALUATION

Questions

1. The results of too slow a cut would be:
   a. Slag along the edges of the cut
   b. An irregular cut
   c. A sloping grain to the cut
   d. All of these.
2. If the grade of steel being cut is not known it may be determined by:
   a. A spark test
   b. Heating it up
   c. Hammering it
   d. Color test.
3. Why should the tip never be allowed to touch the surface of the metal?

Answers

1. b
2. a
3. It may cause a backfire.

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 99

TASK: Gas weld ferrous/nonferrous metals.

CONDITIONS: Ferrous/nonferrous metal workpiece, a work order to weld them to specifications, flux, welding rods, and the following tools and equipment:

Abrasive
Apron
Brush
Clamps
Oxyacetylene welding equipment
Personal safety equipment
Soapstone or chalks
Tongs
Welding goggles.

STANDARD: When completed, the weld must be as strong as original material and the part or workpiece function as designed. Visual inspection of joints will show smooth and continuous welds, complete penetration, fusion between the weld bead and base metal, no cracks, undercutting or overlap.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed. pp. 2204-2222.

PERFORMANCE GUIDE

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Prepare metal to be welded by cleaning, grinding, positioning.
5. Select torch tip, filler rod, and (flux for nonferrous metals).
6. Open tank valves and adjust pressure to specified readings on regulators.
7. Turn on/light and adjust torch to neutral flame.
8. Preheat workpiece and apply flux.
9. Weld joints to work order specification.
10. Shut off equipment and bleed lines.
11. Clean and allow weld to cool.
12. Check weld for undercut, cracks, or porosity.

ENABLING OBJECTIVES

Demonstrate oxy-gas welding equipment safety practices.

PERFORMANCE OBJECTIVE V-TECS 99

LEARNING ACTIVITIES

1. Explain the difference between fusion and nonfusion welding.
2. Discuss the importance of properly preparing the work and the work area for welding.
3. Emphasize the importance of proper tip, rod and flux selection for the metal(s) being welded.
4. Explain how to determine basic metal types and steel alloys by color, texture and by using a spark test.
5. Show technique by demonstrating flat, vertical and overhead welds.
6. Test the weld strength by hammering in a vise.

RESOURCES

Giachino, et al. **Welding Skill and Practices**, pp. 260-289.

Pender, **Welding**, pp. 41-65.

EVALUATION

Questions

1. Tack welds are used to:
    a. Keep the weld together.
    b. Limit distortion and hold the work pieces in place.
    c. Allow for expansion along the line of fusion.
    d. All of the above.
2. A good vertical weld:
    a. Is made up of several passes
    b. Is made from bottom to top
    c. Has a minimum of undercutting
    d. Is made from top to bottom.
3. The correct way to tell if aluminum has been preheated sufficiently is:
    a. Blue carpenter's chalk will turn white.
    b. Rubbing pine stick on the metal will produce a chalk mark.
    c. If the metal is struck with a hammer no metallic ring will be heard.
    d. All of the above.

Answers

1. b
2. b
3. d

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 100

TASK: Lead solder metals with gas equipment.

CONDITIONS: Metal workpieces, work order, lead solder, fluxes, and the following tools and equipment:

Abrasive
Apron
Brush
Clamps
Gas welding equipment
Personal safety equipment
Tongs
Welding goggles/safety glasses.

STANDARD: When completed, the soldered joints should be smooth, continuous, bonded, and completely sealed.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2195-2198.

PERFORMANCE GUIDE

1. Set up equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Select flux for metal used.
5. Prepare metal for soldering by cleaning, fluxing and positioning.
6. Select welding tip and regular pressures.
7. Open tank valves and adjust pressure.
8. Turn on/light and adjust torch to neutral flame.
9. Heat metal surface.
10. Apply solder.
11. Shut off equipment.
12. Cool and clean joints.
13. Check joints for bond, holes, smoothness and capillary action.

ENABLING OBJECTIVE

Demonstrate oxy-gas equipment safety procedures.

PERFORMANCE OBJECTIVE V-TECS 100

LEARNING ACTIVITIES

1. Show various types of gas apparatus that may be used in soldering.
2. Explain the principle of capillary action, by which, the solder fills the joint.
3. Prepare two surfaces for soldering by using flux and by tinning the joint.
4. Demonstrate soldering techniques in seam and sweat soldering.
5. Demonstrate washing of the work to stop later corrosive action.

RESOURCES

Giachino, et al. **Welding Skills and Practices,** pp. 305-311.

Pender, **Welding,** p. 163.

EVALUATION

Questions

1. What is meant by tinning?
2. During the soldering process, why should parts be held securely?
3. What is the difference between seam soldering and sweat soldering?
4. What type of heat sources may be used for soldering?

Answers

1. Tinning is the process of applying a thin coating of soldering over the joint before soldering it, which allows the solder to flow more easily.
2. Parts should be held securely because any movement will weaken the joint.
3. Seam soldering is used on a butt joint and sweat soldering is used on a lap joint.
4. Electric and gas.

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 101

TASK: Silver braze metals with gas equipment.

CONDITIONS: Metal workpieces, work order with specifications, flux and silver brazing alloy, and the following tools and equipment:

Abrasive
Apron
Brush
Clamps
Gas welding equipment
Personal safety equipment
Tongs
Welding goggles/safety glasses.

STANDARD: When completed, visual inspection will show complete joint penetration, 100 percent coverage of joint surfaces, and complete adherence to base metal.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Set up equipment.
2. Ventilate the work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Check silver content of solder.
5. Prepare metal for silver brazing by cleaning, fluxing, positioning.
6. Select welding tip and regulator pressures.
7. Open tanks and adjust pressure.
8. Turn on/light and adjust torch to neutral flame.
9. Heat metal, flux and apply brazing alloy.
10. Shut off equipment.
11. Cool, clean, and check joint for penetration, bond, holes, and smoothness.

ENABLING OBJECTIVE

Demonstrate oxy-gas welding equipment safety procedures.

LEARNING ACTIVITIES

1. Explain the principle of capillary action.
2. Describe the purpose and application of flux and silver brazing.
3. Emphasize the importance of clean metal for a strong bond.

Learning Activities Continued

4. Show how to select the proper tip for the metal being welded as well as the correct time.
5. Demonstrate several lap joints using the silver brazing process.

RESOURCES

Pender, **Welding,** pp. 91-93.

Giachino, et al. **Welding Skills and Practices,** p. 306.

EVALUATION

Questions

1. Another name for silver brazing is:
    a. Hard soldering
    b. Capillary action
    c. Fusion
    d. Tinning.
2. Which of the following metals can be silver brazed?
    a. Copper and brass
    b. Aluminum and steel
    c. Iron and brass
    d. All of the above.
3. Which type of joint is best suited to silver brazing?
    a. Butt joint
    b. Tee joint
    c. Lap joint
    d. Edge joint.

Answers

1. a
2. d
3. c

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 102

TASK: Shape (form) metals using gas welding equipment.

CONDITIONS: Metal stock, a work order to shape it to specifications, and the following tools and equipment:

Abrasive
Anvil
Apron
Brush
Clamps
Hammers
Pattern or measuring devices
Personal safety equipment
Soapstone or chalk
Tongs
Welding goggles/safety glasses.

STANDARD: When completed, the metal workpiece must conform to the work order specifications to within ±1/16" and be free of scales, puddles, holes and cracks.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Lay out bends/shapes/forms on metal stock.
5. Select approaches.
6. Select hand tools.
7. Position metal.
8. Select torch tip.
9. Open tanks and adjust pressure to equipment manufacturer's specifications.
10. Turn on/light and adjust torch to neutral flame.
11. Heat metal to cherry red.
12. Shape (form) metal to specifications in work order.
    NOTE: Metal may have to be heated several times between hammering.
13. Shut off welding equipment and bleed lines.
14. Cool work and check to specifications.

PERFORMANCE OBJECTIVE V-TECS 102

ENABLING OBJECTIVE

Demonstrate correct safety procedures using oxy-gas welding equipment.

LEARNING ACTIVITIES

1. Explain the characteristics of metal forging, expansion, contraction and distortion.
2. Describe hand forging, heat forming, bending of pipe, shrinking processes and basic pattern making.
3. Specify proper top selection according to the thickness and size of metal.
4. Demonstrate metal ductility and temperature according to color.
5. Demonstrate metal forming and forging using forms, vises and anvils.

RESOURCES

Pender, **Welding**, p. 15.

Johnson, **Technical Metals**, pp. 216-220.

EVALUATION

Questions

1. When metal is heated it:
   - a. Shrinks
   - b. Becomes more ductile
   - c. Distorts
   - d. Fuses.
2. The metal must be heated uniformly and be without:
   - a. Puddles or inclusions
   - b. Spalling or scales
   - c. Crystallization or holes
   - d. All of the above.
3. Steel that changes in color from bright orange to dull red indicates:
   - a. An increase in temperature
   - b. A decrease in temperature
   - c. High carbon steel
   - d. Crystallization of the metal.

Answers

1. b
2. c
3. b

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 103

TASK: Weld ferrous/nonferrous metals with MIG equipment.

CONDITIONS: Ferrous/nonferrous workpieces, a work order to weld them to specifications, type of current, type of gas, filler wire, and the following tools and equipment:

Abrasive
Apron
Brush
Clamps
MIG welding unit
Personal safety equipment
Tongs
Welder's helmet w/shade
Welding goggles/safety glasses.

STANDARD: When completed, the weld must be as strong as original material and the part or workpiece function as designed. Visual inspection of joints will show smooth and continuous welds, complete penetration, fusion between the weld bead and base metal, no cracks, undercutting or overlap.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2204-2222.

PERFORMANCE GUIDE

1. Set up equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Prepare metal to be welded by cleaning, grinding, positioning.
5. Position all cables and hoses so they are neither burned or damaged.
6. Attach ground cable.
7. Turn on electrical equipment.
8. Turn on/adjust water flow.
9. Turn on/adjust shielding gas.
10. Adjust wire feed, voltage, amperage and stick-out.
11. Weld joints using fillet and groove welds in all positions according to work order.
12. Shut off equipment.
13. Clean welds and cool.
14. Check/test welds.

PERFORMANCE OBJECTIVE V-TECS 103

ENABLING OBJECTIVES

Demonstrate arc welding technique.

Demonstrate safety practices with pressurized gases.

LEARNING ACTIVITIES

1. Explain the advantage of MIG welding processes.
2. Describe the various types of metal transfer and arc shielding processes.
3. Show the equipment and explain the set up of the various controls, and preliminary equipment checks.
4. Show examples of both automatic and semi-automatic equipment.
5. Demonstrate weld joints using fillet and groove welds in all positions.
6. Check and test welds.

RESOURCES

Giachino, et al. **Welding Skills and Practices,** pp. 194-237.

Pender, **Welding,** pp. 169-182.

EVALUATION

Questions
1. What do the letters M.I.G. stand for?
2. What are some advantages of M.I.G. welding?
3. What is the usual distance of electrode stick out?
4. How is the amperage controlled on a M.I.G machine?

Answers
1. Metal arc Inert Gas.
2. Easy, cleanup, speed, and excellent penetration.
3. About 1/4".
4. By the wire feed mechanism.

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 104

TASK: Weld ferrous/nonferrous metals with TIG equipment.

CONDITIONS: Ferrous/nonferrous metal workpieces, a work order to weld them to specifications using fillet and groove welds, fiber rod, type of current, type of tungsten, shielding gas, flow rate, filler rod, and the following tools and equipment:

Abrasive
Apron
Brush (varies with materials)
Clamps
Electrodes
Personal safety equipment
Soapstone or chalk
TIG welding unit
Tongs
Welding goggles/safety glasses
Welder's helmet with shade.

STANDARD: When completed, the weld must be as strong as the workpiece. Visual inspection of joints will show smooth and continuous welds, complete penetration, fusion between the weld bead and base metal, and no cracks, undercutting or overlap.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2204-2228.

PERFORMANCE GUIDE

1. Set up equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Prepare metal to be welded by cleaning, grinding, positioning.
5. Position all cables and hoses so they are neither burned or damaged.
6. Attach ground cable.
7. Turn on electrical equipment.
8. Turn on and check water flow as required.
9. Turn on and adjust shielding gas.
10. Select/adjust tungsten.
11. Adjust current.
12. Adjust high frequency.
13. Weld joints in all positions according to work order.
14. Shut off equipment.
15. Clean welds and cool.
16. Check/test welds.

PERFORMANCE OBJECTIVE V-TECS 104

ENABLING OBJECTIVES

Demonstrate proper arc welding technique.

Demonstrate safety practices with pressurized gases.

LEARNING ACTIVITIES

1. Explain the advantages of the TIG welding process.
2. Describe the TIG process and equipment used.
3. Demonstrate proper equipment setup, of argon, regulator, cooling water, rod extension, and polarity.
4. Demonstrate horizontal welds with and without welding rod, also show correct procedure for starting welds using a copper block.
5. Show vertical welding technique and inspect the welds for flaws.

RESOURCES

Pender, **Welding**, pp. 169-182.

Giachino, et al. **Welding Skills and Practices**, pp. 161-189.

EVALUATION

Questions

1. What factor determines whether an air cooled or gas cooled torch is used?
   a. Thickness or metal
   b. Amperage
   c. Size of filler rod
   d. Rate of inert gas flow.
2. Which of the following metals(s) can TIG welding be used on?
   a. Steel
   b. Aluminum
   c. Magnesium
   d. All of the above.
3. How far shoud the electrode extend beyond the edge of the gas cup?
   a. 1/8" - 3/16"
   b. 1/4"
   c. 3/4"
   d. 1/4" - 5/6"

Answers

1. b
2. d
3. a

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 105

TASK: Arc-weld ferrous/nonferrous metals.

CONDITIONS: Iron/steel workpieces, a work order to weld them to specifications, and the following tools and equipment:

Abrasive
Apron
Arc-weld
Clamps
Personal safety equipment
Slag hammer
Steel brush
Stick electrodes
Tongs
Welding goggles/safety glasses
Welding helmet/shade.

STANDARD: When completed, the weld must be as strong as the workpieces; and visual inspection will show smooth and continuous welds, fusion between the weld bead and base metal, complete penetration, and no cracks, undercutting or overlap.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2204-2228.

PERFORMANCE GUIDE

1. Set up arc-welder.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Prepare metal to be welded by cleaning, grinding, positioning.
5. Attach ground clamp.
6. Turn on and adjust welding machine.
7. Select electrode.
8. Weld the joint(s) according to work order specifications.
   NOTE: Slag must be removed between passes.
9. Shut off welder.
10. Clean finished weld. Allow to cool.
11. Test.

ENABLING OBJECTIVE

Demonstrate control of electrodes.

PERFORMANCE OBJECTIVE V-TECS 105

LEARNING ACTIVITIES

1. Emphasize the importance of proper protective gear.
2. Inspect safety gear, equipment and work area for defects or hazards.
3. Explain how to select the proper size and composition of electrode for the work being welded.
4. Explain the function and proper procedure for setting the controls on the arc welder.
5. Show how to start an arc, preparation of the metal and how to tack weld the work.
6. Demonstrate horizontal, vertical and overhead butt joints.
7. Demonstrate proper cleaning of weld before the next pass.

RESOURCES

Johnson, **Technical Metals,** pp. 274-282.

Giachino, **Welding Skills and Practices,** pp. 97-124.

EVALUATION

Questions

1. Which of these is NOT characteristic of a poor weld?
   a. Puddling
   b. Undercutting
   c. Irregular
   d. Impurities.
2. Which of the following are essential for a good weld?
   a. Angle, temperature, electrode
   b. Control, angle, speed, current, length of arc
   c. Current, comfort, speed, position, arc, weave
   d. Fillet, pass, comfort, length or arc, speed.
3. Surfaces which are properly prepared for butt welding should be:
   a. V ground
   b. Have proper gap
   c. Tacked
   d. All of the above.

Answers

1. a
2. b
3. d.

Practical Application

Refer to Checklist Performance Objective 105. Arc-weld Ferrous/Nonferrous Metals.

PERFORMANCE OBJECTIVE V-TECS 105

Evaluation Continued

Method of Evaluation

Use Checklist Performance Objective 105 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 105
EVALUATION

PERFORMANCE TEST FOR ARC WELD FERROUS/NONFERROUS METALS

Student's Name Date

DIRECTIONS TO STUDENT: The student will arc weld butt lap. and tee joints in the flat position using 3/16" plate 5" X 3" and use 1/8", 6011 electrode.

DIRECTIONS TO EVALUATOR: This test will be divided into two parts. Part 1 is a preliminary equipment check and part 2 is an evaluation of the welds themselves.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
Part I: Set Up Check List		
1. The welding area is clean, ready for use and is properly shielded.		
2. The equipment is inspected prior to use.		
3. The ground clamp is properly secured.		
4. The welder has on the proper welding equipment.		
5. The machine is set for the correct polarity.		
6. The amperage control is set for the approximate current for the electrode to be used.		
7. Slag removal equipment is available.		
8. The main power switch is turned on for welding.		
Part II: Weld Analysis Check List		
1. Even bead ripples.		
2. Weld beads uniform in width and height.		
3. Full penetration.		
4. Excessive penetration.		
5. Poor penetration.		
6. Weld beads broken loose from parent metal (cold laps).		
7. Surface porosity.		
8. Crater cracks.		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
9. Undercutting.	____________	____________
10. End crater filled.	____________	____________
11. Weld properly cleaned	____________	____________
12. Joints straight, parallel or perpendicular	____________	____________

Approved: Yes ____ No ____

5 points/section Total 100

Evaluator's Signature

Date

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 106

TASK: Install/replace gas welding regulators.

CONDITIONS: Oxyacetylene welding equipment, gas welding regulators, soapy water, and the following tools and equipment:

Apron
Manufacturer's specifications
Personal safety equipment
Tag
Torch wrench or other close fitting wrenches
Welding goggles/safety glasses.

STANDARD: When completed, the gas welding regulators will have been installed/replaced and will operate without leaks according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Tag out equipment.
2. Check to see that cylinder (fuel and oxygen) valves are closed. Close as required.
3. Remove pressure from hose line (bleed) until regulators read "zero" by loosening and opening torch valves.
4. Disconnect torch hoses from regulator/check valve by loosening nuts at regular outlet. CAUTION: Fuel = left hand thread. Oxygen = right hand thread.
5. Place hose/torch assembly in clean area free of oil or grease.
   CAUTION: Oxygen under pressure in contact with grease creates explosions.
6. Disconnect regulators from cylinder valves. Place in clean area free of oil or grease.
7. Install regulators on cylinders. Check regulator inlet screens and tail pieces for cleanliness and smooth seats.
   a. New Cylinder. Crack cylinder (rapid on-off) to clear dust, dirt or other foreign particles. Clean regulator inlet seat by wiping with dry cloth. Insert regulator seat into regulator valve and tighten nut.
   b. Continued Use Cylinder. Clean regulator inlet seat by wiping with dry cloth. Insert regulator seat into regulator valve and tighten nut.
8. Reconnect hoses to regulator/check valve.
9. Open tank valves to desired pressures.
10. Check for leaks with soapy water.
11. Select/install torch.

Learning Activities Continued

12. Turn on/light/adjust torch to manufacturer's specifications.
13. Shut off welding equipment and bleed lines.
14. Remove tag.

ENABLING OBJECTIVES

State how to light and shut down system.
Observe safety procedures.

LEARNING ACTIVITIES

1. Emphasize the dangers inherent in working with pressurized gases.
2. Point out the explosion hazard from pressurized oxygen in contact with oil or grease.
3. Identify the characteristics that are peculiar to acetylene and oxygen regulators.
4. Demonstrate removal of the regulators following manufacturer's specifications.
5. Show proper installation of regulators following manufacturer's specifications.
6. Demonstrate leak testing of the equipment, light and adjust torch.

RESOURCES

Giachino, et al. **Welding Skills and Practices**, pp. 252-259.

Johnson, **Technical Metals**, pp. 265-269.

EVALUATION

Questions

1. An explosive combination is:
    a. Oxygen and oil
    b. Acetylene and oil
    c. Grease and flame
    d. Acetone and oil.
2. The method used to purge any dirt or dust from the cylinder valve is called:
    a. Purging
    b. Evacuating
    c. Cracking
    d. Blasting.

Evaluation Continued

3. Fuel lines may be identified by:
    a. Right hand threads
    b. Green colored lines
    c. Left hand threads
    d. Slightly large dial hose.

Answers

1. a
2. c
3. c

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 107

TASK: Install/replace gas welding torches.

CONDITIONS: Oxyacetylene welding equipment, gas welding torch, soapy water, and the following tools and equipment:

Apron
Manufacturer's specifications
Personal safety equipment
Torch wrench or suitable close fitting wrench
Welding goggles/safety glasses.

STANDARD: When completed, the torch will have been installed and the gas welding equipment will operate according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Tag out equipment.
2. Check to see that cylinder (fuel and oxygen) valves are closed. Close as required.
3. Remove pressure from hoses until regulators read zero by loosening regulator adjustment screw.
4. Remove torch assembly from hoses by loosening torch handle fitting. CAUTION: Fuel line = left hand and oxygen line = right hand.
5. Select new/replacement torch head/handle assembly.
6. Connect hoses to torch assembly. Check seating surfaces for cleanliness and smoothness. Tighten torch handle fitting.
7. Select/install torch tip.
8. Open tank valves to desired pressures.
9. Check for leaks with soapy water.
10. Turn light/adjust torch.
11. Check for operation according to specifications.
12. Shut off welding equipment and bleed lines.

ENABLING OBJECTIVE

Set pressures on regulators.

PERFORMANCE OBJECTIVE V-TECS 107

LEARNING ACTIVITIES

1. Explain safety procedures related to oxy-gas welding equipment.
2. Identify cause of explosion and flashback related to improper handling of oxy-gas equipment.
3. List inspection points of the equipment and identify faults that are hazardous.
4. Demonstrate selection, inspection, cleaning of tips and proper replacement procedure.
5. Check equipment for leaks and for correct operation as per manufacturer's specifications.
6. Demonstrate proper shut down and shut off of equipment.

RESOURCES

Johnson, **Technical Metals,** p. 269.

Giachino, et al. **Welding Skills and Practices,** pp. 252-259.

EVALUATION

Questions

1. The proper method of testing for gas leaks is:
   a. With a soapy solution
   b. With a match
   c. By listening
   d. With a vapor ionization tester.
2. When shutting off an oxyacetylene torch the proper method is to:
   a. Turn off the oxygen before the acetylene
   b. Turn off acetylene before the oxygen
   c. Turn both off together
   d. Either way, doesn't matter.
3. A backfire may be caused by:
   a. Touching the tip against the work
   b. Overheating the tip
   c. Operating the tip at lower pressures than recommended for it
   d. All of the above.

Answers

1. a
2. b
3. d

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 108

TASK: Anneal metals.

CONDITIONS: A plain carbon steel workpiece, specifications for heating and annealing, and the following tools and equipment:

Abrasive
Apron
Clamps
Machinery's handbook or heat-treatment color charts
Oxyacetylene torches
Oxyacetylene welding equipment
Personal safety equipment
Steel brush
Tongs
Welding goggles/safety/glasses.

STANDARD: When completed, the workpiece will have been heated to specified temperature for specified duration and annealed according to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2135-2175.

PERFORMANCE GUIDE

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Prepare workpiece for heating/annealing.
5. Select/install torch tip.
6. Open tank valves and adjust pressure to specified reading on regulators.
7. Turn on/light adjust torch to specified flame.
8. Heat workpiece to specified temperature for specified duration. Refer to heat-treating color charts as necessary.
9. Shut off welding equipment and bleed lines.
10. Clean/cool workpiece according to specifications.

ENABLING OBJECTIVE

State how to run oxyacetylene welding equipment.

PERFORMANCE OBJECTIVE V-TECS 108

LEARNING ACTIVITIES

1. Explain the purposes for heating metals and the properties given to the metal by the annealing process.
2. Display a color chart for plain carbon steel and explain the temperatures indicated by the various colors of the spectrum.
3. Demonstrate metal temperature and color range by heating a piece of steel.
4. Demonstrate annealing of the metal by allowing the metal to cool slowly in an oven, burying it in lime, or surrounding it in some other insulating material.
5. Show the results of the process by testing similar annealed and plain carbon steel pieces.

RESOURCES

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2135-2175.

Giachino, et al. Weeks. **Welding Skills and Practices**, p. 24.

EVALUATION

Questions

1. Annealing is a process that ________________________ the metal.
   a. Hardens
   b. Tempers
   c. Softens
   d. Stresses
2. Temperatures required for annealing are in the ________________ range.
   a. 700 - 1200 degrees
   b. 900 - 1400 degrees
   c. 1400 - 1600 degrees
   d. 1500 - 1750 degrees
3. The annealing process is commonly used on which of the following metals?
   a. Steel
   b. Aluminum
   c. Copper
   d. All of the above.

Answers

1. c
2. d
3. d

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 109

TASK: Harden metals.

CONDITIONS: A plain carbon steel workpiece, specifications for hardening, and the following tools and equipment:

Abrasive
Apron
Clamps
Machinery's handbook or heat treatment color charts
Oxyacetylene torches
Oxyacetylene welding equipment
Personal safety equipment
Quenching bath as needed (water, brine, caustic soda, oils)
Steel brush
Tongs
Welding goggles/safety/glasses.

STANDARD: When completed, the workpiece will have been heated to specified temperatures for specified durations, and quenched according to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2135-2175.

PERFORMANCE GUIDE

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Prepare quenching bath as necessary.
5. Prepare workpiece for heating/hardening.
6. Select/install torch tip.
7. Open tank valves and adjust pressure to specified reading on regulators.
8. Turn on/light/adjust torch to specified flame.
9. Heat workpiece to specified temperatures for specified durations. Refer to heat-treating charts to specifications.
10. Quench, workpiece according to specifications.
11. Shut off welding equipment and bleed lines.
12. Dismantle/store quenching bath as necessary.

ENABLING OBJECTIVES

State how to run oxyacetylene welding equipment.

PERFORMANCE OBJECTIVE V-TECS 109

LEARNING ACTIVITIES

1. Explain the purposes for hardened metals.
2. Describe the basic steps in hardening metals and the importance of precise temperatures for each grade of steel being treated.
3. Show proper set up for the heat treating procedure with oxyacetylene torches, charts, handtools and quenching bath.
4. Demonstrate the quenching procedure following heat treatment specifications.
5. Test the material for hardness by using either a spark test or a Brinell hardness tester if available.

RESOURCES

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2135-2175.

Giachino, et al. **Welding Skill and Practices**, p. 24.

EVALUATION

Questions

1. The two basic steps in the hardening process are heating and:
   a. Hardening
   b. Cooling
   c. Quenching
   d. Tempering.
2. Which of these pieces of equipment are used in the hardening procedure?
   a. Brinell tester, heat source
   b. Thermometer, heat source
   c. Heat source, quenching bath
   d. Tempering device, heat source.
3. The ability of a steel to be hardened depends upon its grain and:
   a. Carbon content
   b. Temperature range
   c. Ductility
   d. All of the above.

Answers

1. c
2. c
3. a

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 110

TASK: Normalize metals.

CONDITIONS: A plain carbon steel workpiece, specifications for heating and normalizing, and the following tools and equipment:

- Abrasive
- Apron
- Clamps
- Machinery's handbook or heat-treatment color charts
- Oxyacetylene welding equipment
- Personal safety equipment
- Steel brush
- Tongs
- Welding goggles/safety glasses.

STANDARD: When completed, the workpiece will have been heated to specified temperatures for specified durations, and normalized according to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2135-2175.

PERFORMANCE GUIDE

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Prepare workpiece for heating/normalizing.
5. Select/install torch tip.
6. Open tank valves and adjust pressure to specified reading on regulators.
7. Turn on/light/adjust torch to neutral flame.
8. Heat workpiece to specified temperatures for specified durations. Refer to heat-treating color charts as necessary.
9. Shut off welding equipment and bleed lines.
10. Clean/cool workpiece according to specifications.

ENABLING OBJECTIVES

State how to light and shut down system.

PERFORMANCE OBJECTIVE V-TECS 110

LEARNING ACTIVITIES

1. Explain the purpose of normalizing metals.
2. Describe how normalizing improves the condition of the steel for further heat treating processes.
3. Explain the similarities between normalizing and annealing.
4. Show proper setup of equipment and work area.
5. Demonstrate the normalizing process, following specifications for heating and cooling.

RESOURCES

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2135-2175.

Johnson, **Technical Metals**, pp. 305-314.

EVALUATION

1. Normalizing is similar to the ________________ process.
   a. Tempering
   b. Carburizing
   c. Quenching
   d. Annealing
2. The major difference between normalizing and annealing is the:
   a. Higher temperature used
   b. Critical point of the metal
   c. Lower temperatures used
   d. Resulting toughness of the material.
3. The Normalizing process gives the material ____________ structural characteristics.
   a. Denser
   b. Uniform
   c. Stronger
   d. Better

Answers
1. d
2. a
3. b

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 111

TASK: Stress-relieve metals.

CONDITIONS: A plain carbon steel workpiece, specifications for heating and stress-relieving, and the following tools and equipment:

Abrasive
Apron
Clamps
Machinery's handbook or heat-treatment color charts
Oxyacetylene welding equipment
Personal safety equipment
Steel brush
Tongs
Welding goggles/safety glasses.

STANDARD: When completed, the workpiece will have heated to specified temperatures for specified durations and stress-relieved according to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2135-2175.

PERFORMANCE GUIDE

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Prepare workpiece for heating/stress-relieving.
5. Select/install torch tip.
6. Open tank valves and adjust pressure to specified reading on regulators.
7. Turn on/light/adjust torch to specified flame.
8. Heat workpiece to specified temperatures for specified durations. Refer to heat-treatment charts.
9. Shut off welding equipment and bleed lines.
10. Clean/cool workpiece according to specifications.

ENABLING OBJECTIVES

State how to light and shut down system.
Explain when metals need stress - relief.

PERFORMANCE OBJECTIVE V-TECS 111

LEARNING ACTIVITIES

1. Discuss the need for stress relieving metals.
2. Point out the principal methods of stress relieving.
3. Emphasize the importance of following the specifications closely.
4. Demonstrate the stress relieving process using oxyacetylene torches as a heat source and following the temperature specifications of the **Machinery's Handbook.**
5. Show how to cool the metal according to **Machinery's Handbook** specifications.

RESOURCES

Oberg, et al. **Machinery's Handbook,** 21st ed., pp. 2135-2175.

Giachino, et al. **Welding Skills and Practices,** pp. 19-41.

EVALUATION

Questions
1. If some metals are not stress relieved they may:
   a. Fatigue
   b. Distort
   c. Crack
   d. All of the above.
2. The two most common methods of stress relieving are heat treating and:
   a. Bending
   b. Pickling
   c. Sand blasting
   d. Unloading.
3. The approximate critical temperature for stress relieving is:
   a. 900 degrees F.
   b. 1100 degrees F.
   c. 1400 degrees F.
   d. 1700 degrees F.

Answers
1. c
2. a
3. b

DUTY: PERFORMING WELDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 112

TASK: Temper metals.

CONDITIONS: A pre-hardened plain carbon steel workpiece, specifications for tempering, and the following tools and equipment:

Abrasive
Apron
Machinery's handbook or heat-treatment color charts
Oxyacetylene welding equipment
Personal safety equipment
Steel brush
Tempering bath as needed (oil, salt, sand, etc.)
Tongs
Welding goggles/safety glasses.

STANDARD: When completed, the workpiece will have been heated to specified temperatures for specified durations, and tempered according to specifications.

SOURCE FOR STANDARD
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2135-2175.

PERFORMANCE GUIDE

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials. Remove if necessary.
4. Prepare tempering bath according to specifications.
5. Prepare workpiece for heating/tempering.
6. Select/install torch tip.
7. Open tank valves and adjust pressure to specified readings on regulators.
8. Turn on/light/adjust torch to specifications.
9. Heat workpiece to specified temperatures for specified duration. Refer to heat-treating color charts as necessary.
10. Immerse workpiece in tempering bath according to specifications.
11. Shut off welding equipment and bleed lines.
12. Dismantle/store tempering bath as necessary.

ENABLING OBJECTIVES

State how to light and shut down system.
Use tempering equipment.

PERFORMANCE OBJECTIVE V-TECS 112

LEARNING ACTIVITIES

1. Explain the need for tempering steels.
2. Describe the structural characteristics of hardened steel and tempered steel.
3. Demonstrate set up of equipment and explain the tempering process.
4. Show the heating process following specifications in a tempering bath until the correct temperature is reached.
5. Demonstrate the cooling process using the tempering bath.

RESOURCES

Oberg, et al. **Machinery's Handbook,** pp. 2135-2175.

Giachino, et al. **Welding Skills and Practices,** pp. 19-41.

EVALUATION

Questions

1. Hardened metals are tempered because they are too:
    a. Hard
    b. Dense
    c. Brittle
    d. High in carbon.
2. Tempering baths may use:
    a. Oil
    b. Salt
    c. Sand
    d. All of the above.
3. The best advice to accurately measure the bath temperature is :
    a. Pyrometer
    b. Thermometer
    c. Gauge
    d. Hydrometer.

Answers

1. c
2. d
3. a

PERFORMING CARPENTRY OPERATIONS

DUTY: PERFORMING CARPENTRY OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 113

TASK: Cut lumber to size with table saw.

CONDITIONS: Lumber, dimensioned sketch of finished workpiece(s), and the following tools and equipment:

Personal safety equipment
Push stick
Rip fence
Rule
Square
Table saw (adequately guarded).

STANDARD: When completed, the cut stock must be within 1/8" of specified dimension.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Select working edge and working end.
2. Lay out stock.
3. Set rip fence to desired width of material (1/16" over finished dimension). Check dimension and squareness.
4. Turn on saw.
5. Rip scrap piece to width and adjust fence if necessary. CAUTION: Shut off saw before making adjustments.
6. Rip pieces of material desired.
7. Shut off saw.
8. Clean up.

ENABLING OBJECTIVES

Use hand tools, rule, square.
Use power tools, table saw.
Use personal safety equipment.
Read sketches and drawings.

LEARNING ACTIVITIES

1. Instruct students to read **Carpentry and Building Construction.** Unit 11, page 148.
2. After reading item 1, direct students to identify hand tools.
3. Demonstrate measuring skills.

PERFORMANCE OBJECTIVE V-TECS 113

Learning Activities Continued

4. Demonstrate how to perform squaring technique.
5. Demonstrate how to make cut using table saw.
6. Show how to check measurements for accuracy.

RESOURCES

Feirer, et al. **Carpentry and Building Construction** (revised) unit 11, p. 148.

EVALUATION

Questions

1. To check squareness of work you would need a ______________.
2. Before cutting lumber with table saw you should always use:
    a. Safety equipment
    b. Push stick
    c. Saw guard
    d. All of the above.
3. The saw should be turned off before making adjustments. (True or False)
4. When cutting stock to dimension with table saw, the allowable tolerance is:
    a. ±1/32"
    b. ±1/16"
    c. 1/8" over
    d. 1/4" under.

Answers

1. Square
2. d
3. True
4. a

Practical Application

Student will perform cutting lumber to size with table saw to include:

Cutting irregular shapes with band saw
Cutting lumber to size with hand saw
Cutting lumber to size with portable power saw
Cutting lumber to size with radial arm saw
Constructing and setting forms for concrete work
Constructing and erecting scaffolds.

Method of Evaluation

Use Checklist Performance Objective No. 113 to determine if the assignment was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 113 EVALUATION

PERFORMANCE TEST FOR CUTTING LUMBER TO SIZE WITH TABLE SAW

Student's Name Date

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step, using the Performance Guide provided by the Instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Were all safety precautions followed?	____	____
2. Were reference manuals used?	____	____
3. Did the student use proper tools?	____	____
4. Were the tools used correctly?	____	____
5. If power tools used, was safety checked?	____	____
6. Did student's conduct meet standards?	____	____
7. Did student dress for job requirements?	____	____
8. Did student show interest in job?	____	____
9. Was the task performed without damage?	____	____
10. Did student check for accuracy?	____	____
11. Did student use lock and tag out?	____	____
12. Did student use good housekeeping?	____	____
13. Did student work with minimum supervision?	____	____
14. Was student's work performed to standards?	____	____
15. Was student careful with materials?	____	____
16. Did student show concern for others?	____	____
17. Did student correctly use blue prints?	____	____
18. Did student complete task?	____	____
19. Was the completion time met?	____	____

Approved: Yes ____ No ____

Evaluator's Signature Date

DUTY: PERFORMING CARPENTRY OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 114

TASK: Cut irregular shapes with band saw.

CONDITIONS: A piece(s) of lumber, irregular pattern and the following tools and equipment:

Band saw
Pattern
Pencil
Personal safety equipment.

STANDARD: When completed, the cut piece(s) must be within 1/16" of the pattern.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Trace pattern on stock.
2. Set upper and lower bandsaw guides to 1/4"-1/2" clearance, over material to be cut.
3. Select blade in accordance with radii of cuts.
4. Adjust tension on bandsaw blade.
5. Turn on/set rheostat for material.
6. Make release cuts.
7. Cut irregular shapes.
8. Shut off machine. Apply brake if so equipped.
9. Remove waste.
10. Release tension on saw blade.

ENABLING OBJECTIVES

Use of band saw.
Use of personal protective equipment.
Use drafting tools.

LEARNING ACTIVITIES

1. Show how to draw patterns with pencil.
2. Instruct students to follow pattern outline within tolerance.
3. Demonstrate ability to cut irregular shape.
4. Explain and emphasize work pressure on saw blade.
5. Explain proper setting of clearance.

PERFORMANCE OBJECTIVE V-TECS 114

RESOURCES

Feirer, et al. **Carpentry and Building Construction** (Revised)

EVALUATION

Questions

1. To trace pattern on stock would you need a pattern and pencil, or personal safety equipment and band saw?
2. The pressure on saw blade is very important.
   (True or False)
3. When work is completed you should always ____________.
4. Why should tension be released on blade after use?

Answers

1. Pattern and pencil
2. True
3. Clean-up
4. To relieve stress

Practical Application

Refer to Checklist Performance Objective 114. Cutting irregular shapes with band saw.

Method of Evaluation

Use Checklist Performance Objective 114 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 114 EVALUATION

PERFORMANCE TEST FOR CUTTING IRREGULAR SHAPES WITH BAND SAW

Student's Name Date

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor, items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Were all safety precautions followed?		
2.	Were reference manuals used?		
3.	Did the student use proper tools?		
4.	Were the tools used correctly?		
5.	If power tools used, was safety checked?		
6.	Did student's conduct meet standards?		
7.	Did student dress for job requirements?		
8.	Did student show interest in job?		
9.	Was the task performed without damage?		
10.	Did student check for accuracy?		
11.	Did student use lock and tag out?		
12.	Did student use good housekeeping?		
13.	Did student work with minimum supervision?		
14.	Was student's work performed to standard?		
15.	Was student careful with materials?		
16.	Did student show concern for others?		
17.	Did student correctly use blue prints?		
18.	Did student complete task?		
19.	Was completion time met?		

Approved: Yes ____ No ____

Evaluator's Signature Date

DUTY: PERFORMING CARPENTRY OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 115

TASK: Cut lumber to size with handsaw.

CONDITIONS: Lumber, dimensioned sketch of finished workpiece(s), and the following tools and equipment:

Cross cut saw, hand
Drawing
Framing square
Jack plane or jointer
Pencil
Personal safety equipment
Rip saw, hand
Rule
Saw horse or bench.

STANDARD: When completed, the cut piece(s) should be within 1/16" of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Select working surface and mark.
2. Lay out working edge.
3. Lay out working end square with working edge.
4. Lay out second end.
5. Cut to length 1/16" with cross cut saw.
6. Lay out width.
7. Saw to width (+1/16") with rip saw.
8. Clean up.

ENABLING OBJECTIVES

Use hand tools, hand saw, square.
Use measuring device.
Use personal safety equipment.

PERFORMANCE OBJECTIVE V-TECS 115

LEARNING ACTIVITIES

1. Having selected hand saw, instruct students to perform square cut.
2. Explain the importance of square edge.
3. Explain the difference in securing work to bench or saw horse.
4. Show how to make proper measurements.
5. Explain how to select working surface.
6. Instruct students to read, **Modern Carpentry**, pp. 10-11 and **Carpentry and Building Construction**, pp. 114-115.

RESOURCES

Wagner. **Modern Carpentry**, pp. 114-115.

Feirer, et al. Carpentry and Building Construction (revised), pp. 114-115.

EVALUATION

Questions

1. What is the purpose of a saw horse?
2. To make dimension cuts you would need:
   (a) Rule
   (b) Square
   (c) Plane
   (d) Saw.
3. In order to finish workpiece to specifications you would first need a ____________?
4. The teeth should be sharp and clean for best results.
   (True or False)

Answers

1. A horizontal portable bench for sawing.
2. d
3. Dimensioned sketch
4. True

Practical Application

Refer to Checklist Performance Objective 115. Cut lumber to size with a handsaw.

Method of Evaluation

Use Checklist Performance Objective 115 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 115
EVALUATION

PERFORMANCE TEST FOR CUTTING LUMBER TO SIZE WITH HANDSAW

Student's Name ____________________ Date ____________

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step, using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Were all safety precautions followed?	______	______
2. Were reference manuals used?	______	______
3. Did the student use proper tools?	______	______
4. Were the tools used correctly?	______	______
5. If power tools used, was safety checked?	______	______
6. Did student's conduct meet standards?	______	______
7. Did student dress for job requirements?	______	______
8. Did student show interest in job?	______	______
9. Was the task performed without damage?	______	______
10. Did student check for accuracy?	______	______
11. Did student use lock and tag out?	______	______
12. Did student use good housekeeping?	______	______
13. Did student work with minimum supervision?	______	______
14. Was student's work performed to standards?	______	______
15. Was student careful with materials?	______	______
16. Did student show concern for others?	______	______
17. Did student correctly use blue prints?	______	______
18. Did student complete task?	______	______
19. Was the completion time met?	______	______

Approved: Yes ____ No ____

Evaluator's Signature ____________________ Date ____________

DUTY: PERFORMING CARPENTRY OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 116

TASK: Cut lumber to size with portable power saw.

CONDITIONS: Lumber, dimensioned sketch of finished workpiece and the following tools and equipment:

Rule or measuring tape
Saw horse or work bench
Square (framing)
Pencil
Personal safety equipment
Portable power saw with ripping gauge.

STANDARD: When completed, the workpiece must be within 1/16" inch of specified dimensions.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Select working edge and working end.
2. Lay out stock.
3. Cut working end.
4. Cut to length.
5. Adjust ripping gauge.
6. Rip to width.
7. Clean up.

ENABLING OBJECTIVES

Use power equipment, portable saw.
Use diagrams and sketches.
Use measuring devices.
Use personal safety equipment.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Carpentry**, pp. 27-28 and **Carpentry and Building Construction**, pp. 165-170.
2. Discuss safe use of portable saw.
3. Demonstrate measuring skills.
4. Explain how to adjust ripping gauge.

PERFORMANCE OBJECTIVE V-TECS 116

Learning Activities Continued

5. Demonstrate making cut with portable saw.
6. Emphasize the need to check measurements for accuracy.

RESOURCES

Wagner, **Modern Carpentry,** Unit 2, pp 27-28.

Feirer, et al. **Carpentry and Building Construction** (revised), Unit 12, pp. 165-170.

EVALUATION

Questions

1. You should always wear eye protection when using portable power saw. (True or False)
2. While adjusting ripping gauge you should ___________.
3. While cutting with portable power saw, materials should be held securely. (True or False)
4. When making measurements the tools to use could be a:
   (a) Rule
   (b) Tape
   (c) Square
   (d) All of the above.

Answers

1. True
2. Unplug power source.
3. True
4. d

Practical Application

Refer to Checklist Performance Objective 116. Cut lumber to size with portable power saw.

Method of Evaluation

Use Checklist Performance Objective 116 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 116 EVALUATION

PERFORMANCE TEST FOR CUTTING LUMBER TO SIZE WITH PORTABLE POWER SAW

Student's Name Date

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step, using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Were all safety precautions followed?		
2.	Were reference manuals used?		
3.	Did the student use proper tools?		
4.	Were the tools used correctly?		
5.	If power tools used, was safety checked?		
6.	Did student's conduct meet standards?		
7.	Did student dress for job requirements?		
8.	Did student show interest in job?		
9.	Was the task performed without damage?		
10.	Did student check for accuracy?		
11.	Did student use lock and tag out?		
12.	Did student use good housekeeping?		
13.	Did student work with minimum supervision?		
14.	Was student's work performed to standards?		
15.	Was student careful with materials?		
16.	Did student show concern for others?		
17.	Did student correctly use blue prints?		
18.	Did student complete task?		
19.	Was the completion time met?		

Approved: Yes ___ No ___

Evaluator's Signature Date

DUTY: PERFORMING CARPENTRY OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 117

TASK: Cut lumber to size with radial arm saw.

CONDITIONS: Lumber, dimensioned sketch of finished workpiece(s) and the following tools and equipment:

Pencil
Radial arm saw
Rule or measuring tape
Personal safety equipment.

STANDARD: When completed, the workpiece must be within 1/16" of specified dimensions.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Select working edge and working end.
2. Lay out stock.
3. Adjust radial arm to the rip position and test cut a scrap piece. Adjust if necessary.
4. Rip lumber to width.
5. Adjust radial arm to the cut off position.
6. Square cut working end.
7. Set stop at specified length. Cut to length, check, and make adjustments as necessary. CAUTION: Shut off saw before making adjustments.
8. Cut the piece(s) to length.
9. Clean up.

ENABLING OBJECTIVES

Use of power equipment, radial arm saw.
Use of measuring devices.
Use of sketches and dimensions.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Carpentry**, pp. 37-39 and **Carpentry and Building Construction**, pp. 124-139.
2. Demonstrate measuring skills.

LEARNING ACTIVITIES

3. Discuss safe use of radial arm saw.
4. Explain procedure before making adjustments.
5. Explain the difference between working edge and working end.
6. Emphasize checking measurement for accuracy.

RESOURCES

Wagner, **Modern Carpentry** pp. 37-39.

Feirer, et al. **Carpentry and Building Construction** (revised), Unit 9, pp. 124-137.

EVALUATION

Questions
1. The radial arm saw is a portable tool. (True or False)
2. The radial arm saw can be turned to different angles. (True or False)
3. You should use personal protective equipment while assisting someone using the radial arm saw. (True or False)
4. You should always check dimensions after cutting with radial arm saw. (True or False)

Answers
1. False
2. True
3. True
4. True

Practical Application

Refer to Checklist Performance Objective 117. Cut lumber to size with radial arm saw.

Method of Evaluation

Use Checklist Performance Objective 117 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 117 EVALUATION

PERFORMANCE TEST FOR CUTTING LUMBER TO SIZE WITH RADIAL ARM SAW

Student's Name ______________________ Date ______________________

DIRECTIONS TO STUDENT:	Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step using the Performance Guide provided by the instructor.
DIRECTIONS TO EVALUATOR:	Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Were all safety precautions followed?	________	________
2.	Were reference manuals used?	________	________
3.	Did the student use proper tools?	________	________
4.	Were the tools used correctly?	________	________
5.	If power tools used, was safety checked?	________	________
6.	Did student's conduct meet standards?	________	________
7.	Did student dress for job requirements?	________	________
8.	Did student show interest in job?	________	________
9.	Was the task performed without damage?	________	________
10.	Did student check for accuracy?	________	________
11.	Did student use lock and tag out?	________	________
12.	Did student use good housekeeping?	________	________
13.	Did student work with minimum supervision?	________	________
14.	Was student work performed to standards?	________	________
15.	Was student careful with materials?	________	________
16.	Did student show concern for others?	________	________
17.	Did student correctly use blue prints?	________	________
18.	Did student complete task?	________	________
19.	Was the completion time met?	________	________

Approved: Yes ____ No ____

Evaluator's Signature ______________________ Date ______________________

DUTY: PERFORMING CARPENTRY OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 118

TASK: Construct and set forms for concrete work.

CONDITIONS: Form lumber/plywood, stakes, bracing, material bracing specifications, double headed nails, a blueprint or dimensioned sketch of a concrete structure to be formed, site location sketch, specified elevation point, and the following tools and equipment:

Chalk line
Hammer
Level/plumb
Personal safety equipment
Plumb bob (optional)
Rule or measuring tape
Saw horse or bench
Shovel
Sledge or mall
Transit (optional)
Circular saw or hand saw.

STANDARD: When completed, forms must be level, plumb, square, and within ±1/8 inch of specifications, and braced according to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Determine location of corners and boundaries of forms from blueprint, sketch, and site specifications.
2. Mark location of corners and boundaries on site with chalk line or stakes. Use batter boards and plumb bob if necessary.
   a. Footing
   b. Single Wall Foundation
3. Determine top and bottom elevations from blueprint, sketch, site specifications or surveyor's bench mark.
4. Mark top and bottom elevations at corners on stakes or batter boards.
5. Measure height(s) and length(s) of forming lumber/plywood needed.
   a. Footing
   b. Single Wall Foundation
6. Cut lumber/plywood to dimensions.
7. Fabricate panels if necessary by nailing boards (plywood to 2"x4" studs 24" on center).
8. Set stakes for built-in-place forms if necessary.
9. Set stakes for anchoring and bracing.

Performance Guide Continued

10. Set forms (panels or top board) in place. Use mason line, level/plumb, complete forms, and nail bracing from forms to stacks. Dig/fill level soil as necessary.
    a. Footings
    b. Single Wall Foundation
11. Install ties and spreaders if necessary.
12. Check dimensions, squareness, levelness and plumb. Adjust if necessary.
13. Check bracing. Strengthen if necessary.
14. Clean up.

ENABLING OBJECTIVES

Use of hand tools.
Use of leveling equipment (Transit).
Use of measuring devices.
Use of sketches and blueprints.
Use of personal safety equipment.

LEARNING ACTIVITIES

1. Instruct students to read, **Modern Carpentry**, pp. 43-51, 87-102 and **Carpentry and Building Construction**, pp. 225-226.
2. Explain the difference between a transit level and framing level.
3. Show how to establish top and bottom elevations.
4. Show how to set stakes for anchoring and bracing.
5. Demonstrate to student how to identify surveyor's bench mark.
6. Show how to establish chalk lines.

RESOURCES

Wagner, **Modern Carpentry**, Unit 3, pp. 43-51; Unit 6, pp. 87-102.

Feirer, et al. **Carpentry and Building Construction** (revised), Units 19 and 20, pp. 225-246.

EVALUATION

Questions

1. A chalk line is to ____________.
   (a) Walk on.
   (b) Mark locations.
2. A plumb bob is used for determining __________.
3. A surveyors bench mark is?
4. Why are duplex nails used in forms?

PERFORMANCE OBJECTIVE V-TECS 118

Evaluation Continued

Answers

1. b
2. Vertical exactness
3. A point of known elevation
4. Easily dismantled

Practical Application

Refer to Checklist Performance Objective 118. Construct and set forms for concrete work.

Method of Evaluation

Use Checklist Performance Objective 118 to evaluate student's performance to determine if the task completed with at least 90% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 118 EVALUATION

CHECKLIST TEST FOR CUTTING AND SETTING FORMS FOR CONCRETE WORK

Student's Name _______________ Date _______________

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step, using Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Were all safety precautions followed?	______	______
2.	Were reference manuals used?	______	______
3.	Did the student use proper tools?	______	______
4.	Were the tools used correctly?	______	______
5.	If power tools used, was safety checked?	______	______
6.	Did student's conduct meet standards?	______	______
7.	Did student dress for job requirements?	______	______
8.	Did student show interest in job?	______	______
9.	Was the task performed without damage?	______	______
10.	Did student check for accuracy?	______	______
11.	Did student use lock and tag out?	______	______
12.	Did student use good housekeeping?	______	______
13.	Did student work with minimum supervision?	______	______
14.	Was student's work performed to standards?	______	______
15.	Was student careful with materials?	______	______
16.	Did student show concern for others?	______	______
17.	Did student correctly use blue prints?	______	______
18.	Did student complete task?	______	______
19.	Was the completion time met?	______	______
20.	Item of special interest supplied by instructor?	______	______

Approved: Yes ____ No ____

Evaluator's Signature _______________ Date _______________

DUTY: PERFORMING CARPENTRY OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 119

TASK: Construct and erect scaffolds.

CONDITIONS: A wall, scaffolding lumber (ledger board, ledger support, legs, platform planking, bracing), nails, specifications for work to be done on wall, and the following tools and equipment:

Hammer
Hand saw or portable power saw
Level
Personal safety equipment
Rule or measuring tape
Saw horse or bench
Square
State construction safety code/regulations.

STANDARD: When completed, the scaffold ledger, ledger support, legs, planking, and bracing will be safe and securely nailed in accordance with specifications and state construction safety code/regulations.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Determine height and length of platform planking needed.
2. Cut ledger boards and ledger supports to length if necessary.
3. Nail ledger supports to wall.
4. Nail ledger boards to ledger supports.
5. Raise legs and nail ledger boards to legs. Make sure legs are plumb and ledgers are level. Legs should be long enough to provide for safety railing(s) if necessary. Place supports/anchor under legs if necessary to avoid settling or movement.
6. Nail cross braces to legs in form of X's as needed.
7. Place platform planking on ledger boards. Nail if necessary.
8. Install safety railing(s) if necessary.
9. Check for rigidity and sway. Add bracing if necessary.
10. Clean up.

ENABLING OBJECTIVES

Use of construction safety code.
Use of portable power equipment.
Use of hand tools.
Use of specifications and regulations.

PERFORMANCE OBJECTIVE V-TECS 119

LEARNING ACTIVITIES

1. Instruct students to read **Modern Carpentry**, pp. 445-446 and **Carpentry and Building Construction**, pp. 216-217.
2. Explain the difference between common nails and duplex nails.
3. Show how to attach scaffold to wall.
4. Explain the difference between plump and level.
5. Emphasize use of base plates.
6. Demonstrate to students how to check for rigidity and sway.

RESOURCES

Wagner, **Modern Carpentry**, Unit 22, pages 445-446.

Feirer, et al. **Carpentry and Building Construction** (revised), Unit 18, pp. 216-217.

EVALUATION

Questions
1. A good scaffold should always have:
   a. Base plates
   b. Bracing
   c. Planking
   d. All of the above.
2. The height of scaffold is of little importance.
   (True or False)
3. The scaffold is attached to wall with a ____________.
4. In scaffold construction duplex nails are used. Why?

Answers
1. d
2. False
3. Ledger board
4. Ease of dismantling

Practical Application

Refer to Checklist Performance Objective 119. Construct and erect scaffolds.

Method of Evaluation

Use Checklist Performance Objective 119 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 119 EVALUATION

PERFORMANCE TEST FOR CONSTRUCTING AND ERECTING SCAFFOLDS

Student's Name Date

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step, using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Were all safety precautions followed?		
2.	Were reference manuals used?		
3.	Did the student use proper tools?		
4.	Were the tools used correctly?		
5.	If power tools used, was safety checked?		
6.	Did student's conduct meet standards?		
7.	Did student dress for job requirements?		
8.	Did student show interest in job?		
9.	Was the task performed without damage?		
10.	Did student check for accuracy?		
11.	Did student use lock and tag out?		
12.	Did student use good housekeeping?		
13.	Did student work with minimum supervision?		
14.	Was student's work performed to standards?		
15.	Was student careful with materials?		
16.	Did student show concern for others?		
17.	Did student correctly use blue prints?		
18.	Did student complete task?		
19.	Was the completion time met?		
20.	Items of special interest supplied by instructor.		

Approved: Yes ____ No ____

Evaluator's Signature Date

DUTY: PERFORMING CARPENTRY OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 120

TASK: Patch composition shingle/built-up roof.

CONDITIONS: A leaky roof section, composition roofing materials (shingles or roofing and felt paper), roofing nails, asphalt tar, crushed slag or pea gravel, scaffolding, and the following tools and equipment:

Asphalt heater
Hammer
Manufacturer's installation specifications
Nail puller
Personal safety equipment
Roofing knife
Wide putty knife or scraper.

STANDARD: When completed, the roof section will not leak and the roofing materials will be installed in accordance with manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen, **Developing Troubleshooting Skills**, pp. 124-128.

PERFORMANCE GUIDE

1. Remove or loosen old roofing materials around leak to a minimum of eighteen inches on all sides.
    a. Built-up Roof. Remove crushed slag or pea gravel and all layers of asphalt and felt. Allow for at least twelve inch lap on successive layers of patching felt.
    b. Shingled Roof. Remove defective shingles. Allow for at least a six inch end lap for each successive row.
2. Remove foreign material such as asphalt lumps and nails which could puncture new roofing materials.
3. Install roofing-materials.
    a. Built-up Roof. Apply two dry plies of 15 lb. or one dry ply of 30 lb. felt. Apply three successive layers of asphalt-saturated felt. Overlap successive layers. Mop down and seal each layer in place with about 20 lbs. of hot asphalt over top surface with about 65 lbs. per 100 sq. ft. Apply crushed slag or pea gravel over top coat of asphalt at about 300-400 lbs. per 100 sq. ft. respectively.
    b. Shingled Roof. Apply one layer of 15 lb. felt paper. Install asphalt shingles to fit into existing pattern of rows. Top of last row should fit under existing row.
4. Flash around chimneys or vents with metal flashing or asphalt plastic cement if necessary.
5. Clean up.

PERFORMANCE OBJECTIVE V-TECS 120

ENABLING OBJECTIVES

Use personal safety equipment.
Use handtools, hammer, roofing knife.
Use scaffolding.
Use manufacturer's specifications.

LEARNING ACTIVITIES

1. Instruct students to read **Modern Carpentry**, pp. 195-198, **Carpentry and Building Construction**, Unit 36, and **Carpentry Fundamentals**, pp. 107-171.
2. Perform removal of old material to required standards.
3. Explain the difference between build-up material and shingles.
4. Demonstrate to students how to remove foreign material, lumps, nails.
5. Demonstrate how shingles fit into existing pattern.

RESOURCES

Wagner, **Modern Carpentry**, Unit 10, pp. 195-198.

Feirer, et al. **Carpentry and Building Construction** (revised), Unit 36.

Baker, et al. **Carpentry Fundamentals**, Chapter 8, pp. 167-171.

EVALUATION

Questions

1. You should always remove foreign material from roof before reroofing. (True or False)
2. New shingles should fit into existing pattern. (True or False)
3. How much overlap is recommended for each layer of shingles?
4. When securing shingles to roof only roofing nails should be used. (True or False)

Answers

1. True
2. True
3. Six inches
4. True

Evaluation Continued

Practical Application

Refer to Checklist Performance Objective 120. Patch composition shingle/built-in roof.

Method of Evaluation

Use Checklist Performance Objective 120 to evaluate student's performance to determine if the task was completed with at least 90 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 120 EVALUATION

PERFORMANCE TEST FOR PATCHING COMPOSITION SHINGLE/BUILT-UP ROOF

Student's Name Date

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step, using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for a step by step process.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Were all safety precautions followed?		
2.	Were reference manuals used?		
3.	Did the student use proper tools?		
4.	Were the tools used correctly?		
5.	If power tools used, was safety checked?		
6.	Did student's conduct meet standards?		
7.	Did student dress for job requirement?		
8.	Did student show interest in job?		
9.	Was the task performed without damage?		
10.	Did student check for accuracy?		
11.	Did student check energized circuits?		
12.	Did student use lock and tag out?		
13.	Did student use good housekeeping?		
14.	Did student work with minimum supervision?		
15.	Was student's work performed to standards?		
16.	Was student careful with materials?		
17.	Did student show concern for others?		
18.	Did student correctly use blueprints?		
19.	Were all joints made correctly?		
20.	Was specified lubricant used?		
21.	Did student use "The Equal to Rule" of electrical insulation of connections (equal or better than original insulation)?		
22.	Did student's maintenance procedure correct problem?		

PERFORMANCE OBJECTIVE V-TECS 120

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
23. Did student complete task?	______	______
24. Was the completion time met?	______	______
25. Items of special interest supplied by instructor?	______	______

Approved Yes ____ No ____

Evaluator's Signature Date

DUTY: PERFORMING CARPENTRY OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 121

TASK: Install/replace glass.

CONDITIONS: A broken window pane with sash, replacement glass putty or glazing compound, glazier's tacks, paint, primer, and the following tools and equipment:

Boiled linseed oil
Glass cutter
Hammer
Personal safety equipment
Putty knife
Saw horses or bench
Wood chisel.

STANDARD: When completed, the glass will be secured to the sash. Smooth and uniform fillets of putty/glazing compound will seal the glass without lumps or gaps.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Remove any broken glass slivers if necessary.
2. Remove any old putty with putty knife or wood chisel if necessary.
3. Paint with primer if necessary.
4. Select glass. Lay out and cut if necessary. Allow 1/16" - 1/8" for expansion.
5. Work putty (glazing compound until pliable. Add boiled linseed oil if necessary).
6. Place bead of putty/compound on shoulder of sash.
7. Lay glass on bead of putty. Apply pressure until all edges of glass are sealed against the putty or glazing compound.
8. Secure glass in sash with glazier's tacks.
9. Apply putty to outside of glass. Putty should be applied at an angle (fillet) from the outer edge of the sash to the inner point of the shoulder on which the glass rests.
10. Paint sash if necessary.
11. Clean up.

ENABLING OBJECTIVES

Use glass cutter.
Use putty knife.
Use personal safety equipment.
Use manufacturer's specifications.

PERFORMANCE OBJECTIVE V-TECS 121

LEARNING ACTIVITIES

1. Instruct student to read **Modern Carpentry,** Unit 11, and **Carpentry Fundamentals,** Chapter 9.
2. Have student remove any remaining broken glass from sash.
3. Demonstrate glass cutting to size.
4. Have student to remove old putty and prepare sash, prime if necessary.
5. Explain the need for making the putty pliable.
6. Perform putty application at proper angle (fillet).

RESOURCES

Wagner, **Modern Carpentry,** Unit 11.

Baker, **Carpentry Fundamentals,** Chapter 9.

EVALUATION

Questions

1. When handling glass, protective hand and finger equipment should be worn:
   a. Sometimes
   b. Always
   c. If available.
2. To make putty more pliable, add boiled linseed oil.
   (True or False)
3. Does glass expand with heat?
   a. No
   b. Yes
   c. Sometimes

Answers

1. b
2. True
3. a

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 121 EVALUATION

PERFORMANCE TEST FOR INSTALLING/REPLACING GLASS

Student's Name

Date

DIRECTIONS TO STUDENT: Select and secure proper equipment before evaluation begins. Complete each step before proceeding to next step using the Performance Guide provided by the instructor.

DIRECTIONS TO EVALUATOR: Items of special interest may be added to checklist by instructor. Items not applicable to task evaluation should be marked (NA) and not applied to scoring percentage. The task assignment is complete with at least 90% accuracy of items marked for scoring. Use the Performance Guide for step by step process.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Were all safety precautions followed?		
2.	Were reference manuals used?		
3.	Did the student use proper tools?		
4.	Were the tools used correctly?		
5.	If power tools used, was safety checked?		
6.	Did student's conduct meet standards?		
7.	Did student dress for job requirements?		
8.	Did student show interest in job?		
9.	Was the task performed without damage?		
10.	Did student check for accuracy?		
11.	Did student check energized circuits?		
12.	Did student use lock and tag out?		
13.	Did student use good housekeeping?		
14.	Did student work with minimum supervision?		
15.	Was student's work performed to standards?		
16.	Was student careful with materials?		
17.	Did student show concern for others?		
18.	Did student correctly use blueprints?		
19.	Were all joints made correctly?		
20.	Was specified lubricant used?		
21.	Did student use "The Equal To Rule" of electrical insulation of connections (equal or better than original insulation)?		
22.	Did student's maintenance procedure correct problem?		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
23. Did student complete task?	____	____
24. Was the completion time met?	____	____
25. Items of special interest supplied by instructor?	____	____

Approved: Yes ____ No ____

Evaluator's Signature Date

WORKING METAL WITH HAND OR PORTABLE TOOLS

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 122

TASK: Cut metal stock with hand hacksaw.

CONDITIONS: Metal workpiece, specifications and the following tools and equipment:

File
Hacksaw
Blades
Personal safety equipment
Vise.

STANDARD: When completed, the workpiece will be cut within 1/32 inch of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Walker. **Machining Fundamentals,** pp. 18-19.

PERFORMANCE GUIDE

1. Lay out stock.
2. Select blade.
3. Mount blade in saw frame.
4. Secure workpiece in vise.
5. Saw workpiece to specifications.
6. Smooth edges with file.

ENABLING OBJECTIVES

Use of hand tools, hacksaw, file.
Use of personal safety equipment.
Use of measuring device.

LEARNING ACTIVITIES

1. Instruct student to read **General Industrial Machine Shop,** pp. 182-184.
2. Explain the difference between metal saw and wood saw.
3. Explain the importance of pitch (teeth per inch) of blade.
4. Demonstrate proper clamp procedure using a vise.
5. Explain the importance of when pressure is applied to the saw blade.

RESOURCES

Johnson, **General Industrial Machine Shop,** Unit 26, pp. 182-184.

PERFORMANCE OBJECTIVE V-TECS 122

EVALUATION

Questions

1. Material to be cut should be held in a:
    a. Vise
    b. Hand
    c. Between knees
    d. Pliers.
2. The proper blade to use may have a pitch of:
    a. 14
    b. 18
    c. 32
    d. All of the above.
3. The kerf of a cut is the:
    a. Teeth per inch
    b. Length of blade
    c. Slot cut by saw
    d. Type of steel in blade.

Answers

1. a
2. d
3. c

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 123

TASK: Cut threads with hand tools.

CONDITIONS: Metal workpiece, specifications for tapped threads, lubricant and the following tools and equipment:

Center punch
Deburring tool
Drill motor
Drills
Hammer
Holding device
Personal safety equipment
Prick punch
Scribe
Square/centering head
Tap handles
Taps
Thread plug gage.

STANDARD: When completed, the threads must be smooth and in compliance with specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 1409-1430.

PERFORMANCE GUIDE

1. Secure workpiece in holding device.
2. Locate hole; prick punch, recheck, and center punch.
3. Select tap drill, and drill hole.
4. Select tap and tap wrench.
5. Tap hole and lubricate as necessary. Use starter tap, check for alignment as necessary. Reverse tap to clear cuttings as necessary. Use plug tap or bottom tap as needed.
6. Deburr hole if necessary.
7. Remove/blow out chips with compressed air.
   CAUTION: Protect face.
8. Inspect for compliance with specifications with thread plug gage.
9. Clean up.

ENABLING OBJECTIVES

Use of hand tools, taps, drills.
Use of personal safety equipment.
Use of specifications.

PERFORMANCE OBJECTIVE V-TECS 123

LEARNING ACTIVITIES

1. Direct students to read **General Industrial Machine Shop,** pp. 192-198.
2. Explain the difference between three tap styles, taper, plug, and bottoming.
3. Demonstrate procedure for center punching.
4. Explain the importance of proper lubrication.
5. Show how to thread hole using hand tap.

RESOURCES

Johnson, **General Industrial Machine Shop,** Unit 28, pp. 192-198.

EVALUATION:

Questions

1. A type of tap used to cut screw threads is a:
    a. Bottom tap
    b. Top tap
    c. Circulant
    d. Very hard screw.
2. While tapping a hole, hold the tap as square to the work as possible. (True or False)
3. To thread a pipe inside diameter you could use a:
    a. Bottom tap
    b. Inside tap
    c. Taper tap
    d. Any of the above.

Answers

1. a
2. True
3. c

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 124

TASK: Cut threads with dies.

CONDITIONS: A metal workpiece, specification for the threads, lubricant and the following tools and equipment:

Dies for cutting threads
Diestock (die holder)
File or grinder
Holding device (vise)
Personal safety equipment
Rule
Square
Thread ring gage.

STANDARD: When complete, the threads must be smooth and in compliance with the specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Secure workpiece in vise.
2. Select die.
3. Mount die in diestock (die holder).
4. Bevel the end of workpiece with file or grinder.
5. Mount and square diestock to workpiece.
6. Cut threads and lubricate as necessary.
7. Check threads to specification with thread ring gage.
8. Finish bevel and deburr as necessary.

ENABLING OBJECTIVES

Use of hand tools, drills and dies.
Use personal protective equipment.
Use of specifications.

LEARNING ACTIVITIES

1. Review safety rules in cutting threads with dies.
2. Explain the difference between die types.
3. Explain the need for chamfering.
4. Explain the importance of proper lubrication.
5. Demonstrate thread cutting with a die.

PERFORMANCE OBJECTIVE V-TECS 124

RESOURCES

Johnson, **General Industrial Machine Shop.**

EVALUATION

Questions

1. A die is used for cutting internal threads. (True or False)
2. A die may be held in a die stock or turret lathe. (True or False)
3. The cut threads turn die in which direction?
   a. Clockwise
   b. Turn left
   c. Up and down
   d. Around.

Answers

1. False
2. True
3. Clockwise

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 125

TASK: Hand lap/hone surfaces.

CONDITIONS: A workpiece with ground surface in need of hand lapping or honing, abrasive paper/materials, lapping/honing materials, oil, hone compound, specifications and the following tools and equipment:

Drill motor (if needed)
Lapping equipment
Personal safety equipment
Power hone (if needed)
Wiping rags.

STANDARD: When completed, the workpiece must be honed and/or lapped to ±.0005 inch.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2041-2048.

PERFORMANCE GUIDE

1. Analyze configuration of surface (flat, internal cylindrical, external cylindrical).
2. Inspect/analyze quality of preparation of surface to be lapped/honed.
3. Analyze quality of finished surface desired.
4. Determine amount of stock to be removed.
5. Select honing stone/lapping device/abrasives.
6. NOTE: If lapping, charge the lapping device.
7. Select lubricant.
8. Hone/lap surface to desired finish.
9. Clean and oil surface as needed.
10. Check surface to specifications.

ENABLING OBJECTIVES

Use of abrasive materials, oils, paper, compounds.
Use of lapping surface.
Use of measuring instrument.

LEARNING ACTIVITIES

1. Identify abrasive materials.
2. Show the procedure for hand lapping using compounds.
3. Explain the difference between various compounds.

LEARNING ACTIVITIES Continued

4. Demonstrate the use of lapping block.
5. Emphasize the need for clean surfaces.

RESOURCES

Compound Manufacturer's Label.

EVALUATION

Questions

1. There are specific compounds for each metal, like steel or brass, etc. (True or False)
2. A thick glass surface is a good lapping block. (True or False)
3. While using lapping block you should use:
    a. Circular motion
    b. Up and down motion
    c. Figure eight motion
    d. First one way then the other.

Answers

1. True
2. True
3. c

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 126

TASK: Hand scrape bearing (round) surfaces.

CONDITIONS: A device with a bearing surface in need of scraping, indicator, solutions, specifications and the following tools and equipment:

Indicator material (soft bluing, red lead, lamp black)
Oil can
Personal safety equipment
Scraping tools
Wiping rags.

STANDARD: When completed, the bearing surface(s) will be hand scraped to specifications and will not overheat under operating conditions.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Inspect surface to be scraped for damage, roundness/high/low spots.
2. Apply indicator.
3. Test surface for high/low spots with mating round surface.
4. Scrape bearing surfaces. Repeat steps #2 and #3 until no indicator remains on surface.
5. Deburr scraped surface.
6. Clean and oil surfaces.
7. Check surfaces to specifications and operation without overheating.

ENABLING OBJECTIVES

Use hand tools, scraper.
Use personal safety equipment.
Use indicator materials.

LEARNING ACTIVITIES

1. Explain the difference between grinding and scraping.
2. Show how to apply indicator material to surface to be scraped.
3. Demonstrate high/low test with mating round surface.
4. Explain procedure for deburring scraped surface.
5. Emphasize the importance of accuracy.

PERFORMANCE OBJECTIVE V-TECS 126

RESOURCES

Johnson, **General Industrial Machine Shop.**

EVALUATION

Questions

1. When scraping metal you should wear ________________.
2. What are the colors of indicator material?
   a. Red
   b. White
   c. Blue
   d. Black
3. After scraping, the complete surface should be cleaned and oiled. (True or False)

Answer

1. Leather gloves
2. (c) and (d)
3. True

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 127

TASK: Ream holes with hand reamer.

CONDITIONS: A workpiece with drilled hole(s) to be reamed, blueprint with specifications, lubricant and the following tools and equipment:

Blueprint or specification sheets
Personal safety equipment
Reamers
Tap wrench
Wiping rags
Work-holding device.

STANDARD: When completed, the hole(s) will be hand reamed to +0.001" to +0.005" of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., p. 1539.

PERFORMANCE GUIDE

1. Secure workpiece in work-holding device.
2. Select reamer.
3. Mount reamer in tap wrench.
4. Lubricate if necessary.
5. Ream to specifications.

ENABLING OBJECTIVES

Use hand tools, reamer, vice.
Use safety equipment, personal housekeeping techniques.
Use of specifications.

LEARNING ACTIVITIES

1. Instruct students to read **General Industrial Machine Shop**, pp. 207-211 and **Machine Shop Operations and Set Up**, p. 148.
2. Discuss the different types of reamer.
3. Explain the difference between reamer and taps.
4. Demonstrate reaming with hand reamer.
5. Explain the difference between straight and spiral flutes.

PERFORMANCE OBJECTIVE V-TECS 127

RESOURCES

Johnson. **General Industrial Machine Shop,** Unit 30, pp. 207-211.

Lasco, et al. **Machine Shop Operations and Set Up,** p. 148.

EVALUATION

Questions

1. Reaming is used to smooth the inside of holes to exact size and smoothness.
   (True or False)
2. Which reamer has the greater shearing action?
   a. Straight flutes
   b. Spiral flutes
3. The sizes of hand reamers vary from 1/8" to 1½".
   (True or False)

Answers

1. True
2. Spiral flutes
3. True

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 128

TASK: Remove damaged screws and other threaded hardware.

CONDITIONS: A machine/piece of equipment containing damaged screw(s) or other threaded hardware, specifications, lubricant and the following tools and equipment:

Annealing or normalizing equipment
Center punch
Drill assortment
Electric drill motor
Lock
Personal safety equipment
Screw extractors
Tap wrenches
Taps
Wiping rags
Work-holding device.

STANDARD: When completed, the threaded hardware must be removed and the fit of the original tapped hole maintained.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Select drill.
3. Center punch in center of damaged screw or other threaded fastener. NOTE: Anneal/normalize if necessary.
4. Drill hole in center of damaged fastener.
5. Place screw extractor in hole.
6. Remove damaged screw/fastener.
7. Clean out hole.
8. Inspect threads for burrs and damage.
9. Retap if necessary.

ENABLING OBJECTIVES

Use of hand tools, drill and taps.
Use of personal protective equipment.
Use of lubricants and screw extractors.
How to anneal/normalize.

PERFORMANCE OBJECTIVE V-TECS 128

LEARNING ACTIVITIES

1. Demonstrate correct use of center punch.
2. Explain the difference between the screw extractor and reamer.
3. Explain the importance of selecting the correct drill and screw extractor.
4. Emphasize the need for accurate drilling.
5. Demonstrate how to perform screw extraction.

RESOURCES

Johnson, **General Industrial Machine Shop.**

EVALUATION

Questions

1. Screw extractors are:
   a. Straight
   b. Tapered.
2. Screw extractors are made of soft metal.
   (True or False)
3. A lead hole should always be drilled in damaged screw.
   (True or False)

Answers

1. Tapered
2. False
3. True

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 129

TASK: Drill holes in metal with portable device.

CONDITIONS: A workpiece, specification sheets, lubricants and the following tools and equipment:

Center punch
Deburring tool
Drill motor (portable drill)
Drill tables
Drills
Personal safety equipment
Prick punch
Scribe
Wiping rags
Work-holding device.

STANDARD: When completed, the hole(s) will be drilled to ±0.010" of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook,** 21st ed., p. 1539.

PERFORMANCE GUIDE

1. Secure workpiece in holding device.
2. Lay out hole(s) with scribe, prick punch, recheck.
3. Center punch.
4. Select pilot drill.
5. Chuck pilot drill.
6. Pilot drill hole. Check alignment.
7. Remove pilot drill.
8. Select drill for intermediate or final hole as necessary.
9. Chuck drill.
10. Drill hole to specifications. Lubricate if necessary.
11. Deburr if necessary.

ENABLING OBJECTIVES

Use of hand tools, hammer, center punch.
Use of power tools drill.
Use of personal protective equipment.

PERFORMANCE OBJECTIVE V-TECS 129

LEARNING ACTIVITIES

1. Demonstrate correct method for center punching.
2. Discuss the difference between hand held power drill and bench drill.
3. Demonstrate the securing of work in vise.
4. Emphasize the need for drilling lead or pilot hole.
5. Explain the importance of selecting the proper drills.

RESOURCES

Wagner, **Modern Carpentry.**

EVALUATION:

Questions

1. While drilling one should always use personal ____________________.
2. If drilling large hole, pilot hole should be drilled first.
    a. Always
    b. Sometimes
    c. Never
3. Lubricant is used to:
    a. Make drill run faster
    b. Reduce heat friction
    c. To make hole smooth.

Answers

1. Safety equipment
2. Always
3. b

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 130

TASK: Sharpen hand scrapers with abrasive stones.

CONDITIONS: Hand scrapers (flat, half-round, bearing) needing sharpening, sharpening specifications, lubricant and the following tools and equipment:

Oilstones
Personal safety equipment
Slipstones
Wiping rags.

STANDARD: When completed, the hand scrapers will be free of burrs, clean, and sharpened to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Identify/analyze material/condition/type of scraper.
2. Select sharpening tool for type/material/condition of scraper to be sharpened.
3. Analyze/measure sharpening angle/bevel.
4. Sharpen to specifications. Traverse entire cutting edge at specified bevel angle.
5. Inspect scraper for burrs and sharpness of cutting edge and angle of bevel.
6. Check sharpness of cutting edge and angle of bevel.
7. Clean scraper.
8. Clean abrasive stones.

ENABLING OBJECTIVES

Use hand tools, abrasive stones.
Use of specifications.
Use of personal safety equipment.
Use housekeeping techniques.

LEARNING ACTIVITIES

1. Identify abrasive stones.
2. Explain the difference between the types of abrasive stones.
3. Demonstrate correct sharpening angle.
4. Explain the importance of selecting the sharpening tool to be used.
5. Emphasize the importance of cutting edge and angle of bevels.

PERFORMANCE OBJECTIVE V-TECS 130

RESOURCES

Wagner, **Modern Carpentry.**

EVALUATION

Questions

1. When selecting sharpening tool, type and condition of scraper is very important.
   (True or False)
2. What should you check for after sharpening?
   a. Sharpness
   b. Angle of bevel
   c. Both
3. After using oil stone you should:
   a. Leave as is
   b. Clean
   c. Reoil.

Answers

1. True
2. Both
3. Clean

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 131

TASK: Scrap flat surfaces for mating parts.

CONDITIONS: A device with flat surface mating parts, lubricants, specification sheets and the following tools and equipment:

Indicator (bluing, red lead, lamp black)
Oil can
Personal safety equipment
Scraping tools
Straightedge
Surface plate
Wiping rags.

STANDARD: When completed, the mating parts will operate smoothly and will be hand scraped to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Inspect mating part surfaces for damage.
2. Apply indicator.
3. Test for trueness/high/low points with straightedge and surface plate.
4. Analyze quality of finished surface desired.
5. Scrape surfaces to specifications.
6. Deburr/hone.
7. Test surfaces for trueness/flatness.
8. Repeat steps #2 to #7.
9. Clean and oil mating parts.
10. Check surfaces to specifications and for overheating.

ENABLING OBJECTIVES

Use hand tools, scraping tools.
Use personal safety equipment.

LEARNING ACTIVITIES

1. Demonstrate use of indicator.
2. Explain the difference between indicator substance and lubricants.
3. Demonstrate test for trueness.
4. High or low points with staightedge.
5. Demonstrate how to apply scraping technique.

PERFORMANCE OBJECTIVE V-TECS 131

RESOURCES

Wagner, **Modern Carpentry**.

EVALUATION

Questions

1. To check for trueness use a ________________________.
2. When selecting indicator, bluing is a good choice. (True or False)
3. After scraping surface you should __________ and ________ mating parts.

Answers

1. Straightedge
2. True
3. Clean and oil

DUTY: WORKING METAL WITH HAND OR PORTABLE TOOLS

PERFORMANCE OBJECTIVE V-TECS 132

TASK: Grind surfaces with portable electric hand grinder.

CONDITIONS: A workpiece, specification sheets, lubricants, assortment of abrasives and the following tools and equipment:

Clamping or holding device
Personal safety equipment
Portable electric grinder with grinding attachments
Table of abrasives
Wiping rags
Workpiece.

STANDARD: When completed, the surfaces will be ground to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Inspect grinder for safety conditions.
2. Ring test grinding wheel for cracks. Replace if necessary.
3. Select/mount abrasive attachment (grinding wheel).
4. Secure workpiece in holding device.
5. Grind to specifications. CAUTION: Sparks should be directed away from operator.
6. Clean and inspect surfaces.

ENABLING OBJECTIVES

Use portable power tools.
Use personal safety equipment.

LEARNING ACTIVITIES

1. Identify grinding equipment.
2. Explain the difference between grinding and scraping.
3. Establish from manufacturer's guide the abrasive to use.
4. Demonstrate use of hand grinder.
5. Show how to test grinding wheel for cracks.

RESOURCES

Johnson, **General Industrial Machine Shop,** Unit 86, pp. 476-477.

PERFORMANCE OBJECTIVE V-TECS 132

EVALUATION

Questions

1. While grinding sparks should be directed ____________________.
2. Abrasives are manufactured in grain size, ______________.
    - a. Coarse
    - b. Fine
    - c. Medium
    - d. All of the above
3. Operating a portable grinder requires use of:
    - a. Goggles
    - b. Face shield
    - c. Safety glasses.

Answers

1. Away from operator
2. d
3. Face shield and safety glasses

PERFORMING DRILL PRESS OPERATIONS

DUTY: PERFORMING DRILL PRESS OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 133

TASK: Lubricate drill press.

CONDITIONS: A drill press, lubricants and the following tools and equipment:

Grease gun
Lock
Manufacturer's manual
Oil can
Personal safety equipment
Screw drivers
Wiping rags
Wrench, open/box end.

STANDARD: When completed, oil reservoirs must be full and all grease fittings must be greased/lubricated in accordance with manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out drill press power.
2. Consult manufacturer's manual to determine lubrication specifications and locations.
3. Wipe oil points clean.
4. Wipe grease fittings clean.
5. Check condition of grease fittings. Replace if necessary.
6. Clean machine surface/T-slots.
7. Check oil level gages where existent. Check for leaks.
8. Fill oil reservoirs according to manufacturer's specifications.
9. Recheck oil level gages.
10. Lubricate grease fittings according to specifications.
11. Lightly oil machined surfaces.
12. Wipe off excess lubricants.
13. Unlock power.

ENABLING OBJECTIVES

Use safety procedures when working with electricity.
Use standard procedures for general maintenance of equipment.
Identification of grease and oil fittings.
Determine correct lubricants.
Use standard preventive maintenance procedure and technique.

PERFORMANCE OBJECTIVE V-TECS 133

LEARNING ACTIVITIES

1. Read handbook on electrical safety. Write a complete description of the proper procedures for electrical safety when working on any powered equipment.
2. Attend a lecture on electrical safety given by representative speaker from local power company.
3. Participate in class discussions of safety practices to be followed at all times.
4. Practice lockout procedures on various types of equipment.
5. Read manufacturer's manual concerning general maintenance of the equipment. Describe the standard procedures recommended for general care of the equipment. Read section concerning lubrication and select the proper lubricants for the equipment. Explain reason for selections.
6. Read textbook on preventive maintenance procedures in **General Industrial Machine Shop**, pp. 19 - 24. Write answers to questions at end of section.
7. Participate in class discussions on preventive maintenance procedures commonly followed in industrial plants.
8. Attend a lecture/demonstration given by a representative speaker from a local industrial maintenance shop or department.
9. Tour an industrial plant with the maintenance supervisor. Discuss why and how of maintenance procedures.
10. Read section on lubrication in **Industrial Maintenance**, pp. 56-65.
11. Study vocabulary words on handout. Define each word.
12. Practice lubricating all types of equipment available in school shops.

RESOURCES

Equipment maintenance manuals supplied by manufacturers.

Textbook. Wireman, Terry. **Industrial Maintenance.** Chapter 5, "Lubrication," pp. 56-64.

Textbook. Johnson, Harold V. **General Industrial Machine Shop.** Section 1, "Introduction To Machine Shop Practices," Unit 2, pp. 19-24.

OSHA, **Checklist for General Industry,** S.C. Department of Labor. **Personal Equipment,** pp. 6-7. **Special Industries and Electrical,** pp. 12-14.

Textbook, Jacobs and Turner. **Developing Shop Safety Skills.**

Text/workbook, Woodburn, **Safety for the Industrial Student. Safety Handbook,** prepared by the State Department of Education and Clemson University.

Material available from lubricant manufacturers.

Ronan, W., **Home and Shop Safety Series,** "Using Power Tools," "Personal Safety."

Handout (vocabulary information sheet).

EVALUATION

Questions

1. Why is preventive maintenance so important in any shop facility?
2. List 3 probable failures caused by improper or inadequate lubrication.
3. List 3 common methods used to lubricate equipment.
4. Why is grease better than oil in certain applications?
5. List the steps to be followed when lubricating any machine.

Answers

1. Preventive maintenance is important because it provides the maintenance people a way to keep a close check on the condition of their equipment. A regular monthly inspection, cleaning, and lubrication of each machine is scheduled and carried out. The machine is closely checked for damage and wear while it is being serviced. Any possible problem may be spotted and repaired before it becomes a major breakdown. This system will save down time on equipment, thus increasing productivity, the most important thing in industry today.

2. a. Shafts may freeze to bearing surfaces or cause the bearing to distort due to heat caused by friction.
   b. Rapid wear will cause spindles and drive shafts to run untrue or wobble, causing excessive wear on bearings and sleeves.
   c. Corrosion (rust), the main enemy of all machinery will result if the protective layer of grease or oil is not maintained.

This short list provides only a few of the many possible answers to this question. Lubrication is the primary protection of all moving, mated parts. Other acceptable answers include:

   a. Prevent friction (heat, wear).
   b. Reduce metal to metal contact, preventing wear.
   c. Provide a metal separating wedge of lubricant, which dampens shock loads.
   d. Dissipate heat.
   e. Prevent rust and corrosion.
   f. Barrier against contamination.

3. a. Manually: The man with the hand operated grease gun or hand oiler is the best, and most thorough method of lubricating any piece of equipment.
   b. Gravity or drip: Most commonly used on slowly operating equipment. An oil cup is filled and the lubricant drips onto the parts to be lubricated.
   c. Bath method: The part or parts to be lubricated are partially submerged in a bath of lubricant. As they operate, the lubricant is carried to all other parts of the system.

Evaluation Continued

There are other methods suggested and these are not the only answers. Others listed are:

a. Splash
b. Pressure.

4. Grease, being a thicker more sticky substance, will cling more effectively to the surfaces it is supposed to lubricate. Thus it will stay where it is placed. Oil will run off or be thrown off when the equipment is operated. Selection of the proper lubricant is very important for this reason alone.

5. A suggested procedures list:

a. Make proper use of personal safety equipment.
b. Follow established lockout routine before doing any work.
c. Clean all oil and grease fittings prior to applying lubrication.
d. Check machine for damage. Repair or replace broken/damaged fittings.
e. Clean and inspect all working surfaces for damage or excessive wear.
f. Check for worn or damaged drive belts. Repair or replace if required.
g. Refer to manufacturer's manual for proper lubricants to be used and locations of lubrication points.
h. Apply sufficient lubricant to each lubrication point and wipe clean before moving to next.
i. Apply a light coat of oil to all exposed, bare metal surfaces.
j. Check for spills and drips and general clean-up before moving to next machine.
k. Remove lockout device and turn power back on according to established shop procedures.

Practical Application

Refer to Checklist Performance Objective V-TECS 133-Lubricant Drill Press.

Method of Application

Use Checklist Performance Objective 133 to evaluate student's performance to determine if the task was completed with at least 80 percent accuracy.

PERFORMANCE OBJECTIVE V-TECS 133

Vocabulary Information Sheet

Drill Press Operations

1.	Drill bit:	A tool most frequently used to produce a round hole in a piece of material, commonly called a drill. Metal cutting drills are called twist drills.
2.	Drill Press:	A machine used to drive drill bits and other hole making tools.
3.	Drill motor:	A hand held machine used to drive drill bits and other metal working devices.
4.	Chuck key/ wrench:	The tool used to tighten the jaws of a drill chuck.
5.	Drill chuck:	The device on a drill press, drill motor or other machine used to hold drill bits or other cutting tools.
6.	Vise:	A device for holding workpieces on a machine.
7.	Hold down:	A device for holding workpieces on a machine.
8.	Clamp:	A device for holding workpieces on a machine.
9.	Center punch:	A tool used during layout to mark the center locations for holes or other features.
10.	Center drill:	A special kind of drill, used before attempting to drill hole. Makes an accurate starting hole for a drill bit.
11.	Tap drill:	A drill specifically chosen to drill the proper sized hole so that a tap will cut easily and still produce adequate threads in a hole.
12.	Reamer:	A tool used to accurately size holes after rough drilling.
13.	Hone:	A tool used to produce extremely accurate diameter holes with very smooth straight sides.
14.	Counterbore:	A tool used to enlarge a hole to a specific depth.
15.	Spot face:	An operation which produces a flat smooth surface around a hole.
16.	Countersink:	A tool for enlarging the end of a hole to receive a flathead screw or to remove a burr and clean the edge.
17.	Tapping Center:	A special tool with a pointed end used to steady a tap when it is being turned into the work.

PERFORMANCE OBJECTIVE V-TECS 133

Vocabulary Sheet

Drill Press Operations

18.	Boring tool:	A single point cutting tool used to enlarge the diameter of a hole.
19.	Boring head:	A device to hold a boring tool which provides a method of adjusting the amount of material removed allowing the operator to produce very accurate, straight holes.
20.	Lapping compounds:	A grease with emery or other cutting material mixed with it to be used for producing very smooth, straight holes. Also used to fit mating parts very accurately.
21.	Cutting oil/ lubricant:	Liquids specifically designed to assist with cutting, sizing and polishing.
22.	Tap wrench:	A hand tool designed to turn a tap.
23.	Pilot (counterbore):	A round, smooth plug, sized to fit in a hole so that the counterbore will produce a concentric (centered) hole.
24.	Pilot hole:	An undersized hole drilled first to provide a guide for a larger drill, reamer, or hone. It is also the hole for a counterbore pilot to follow or the rough hole prior to a boring operation.

CHECKLIST FOR PERFORMANCE OBJECTIVE V-TECS 133 EVALUATION

PERFORMANCE TEST FOR CLEANING AND LUBRICATING EQUIPMENT

Student's Name Date

DIRECTIONS TO STUDENTS: This test is a performance test. You will be asked to perform a preventive maintenance check, clean, and lubricate a piece of shop equipment or machinery. The instructor or observer will be grading you on your actual performance. All aspects of your performance will be rated, so do your best as safely, quickly, and efficiently as you can.

DIRECTIONS TO EVALUATOR:

1. Select a student and hand him an assignment sheet or give him oral instructions about what he is to do.
2. Observe the student's method of procedure and note whether he followed established procedures and mark check sheet appropriately.
3. Should the student omit the electrical lock out procedure, the test is to be STOPPED! The student should then be corrected on the spot, informed that a major deduction will be made on his final score for this observation test.
4. Should the student start to do anything which may endanger him or others around him, he is to be STOPPED, corrected, and, at the instructor's decision, allowed to continue. Points are of course deducted from the test score.
5. Time is important but not to stopwatch accuracy. A reasonable length of time should be allowed. Each machine or piece of equipment has special requirements and these should be taken into consideration when the assignment is made. (Instructor preference)
6. Should the student take too much time, note that in your opinion he/she took too much time on the sheet. DO NOT STOP THE STUDENT! Let him/her complete the job. Deduct points according to how long it did take. (Instructor's preference)
7. Inspect student's work on completion and check items 9 and 10. Add points for items properly completed and deduct points for those items partly done or not done. Maximum total score is 100. A minimum grade of 90 is passing.

PERFORMANCE OBJECTIVE V-TECS 133

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Make proper use of personal safety equipment.	________	________
2. Follow established lockout routine before doing any work.	________	________
3. Clean all oil and grease fittings prior to applying lubrication.	________	________
4. Check machine for damage. Repair or replace broken/damaged fittings.	________	________
5. Clean and inspect all working surfaces for damage or excessive wear.	________	________
6. Check for worn or damaged drive belts. Repair or replace if required.	________	________
7. Refer to manufacturer's manual for proper lubricants to be used and locations of lubrication points.	________	________
8. Apply sufficient lubricant to each lubrication point and wipe clean before moving to next.	________	________
9. Apply a light coat of oil to all exposed, bare metal surfaces.	________	________
10. Check for spills and drips and general clean-up before moving to next machine.	________	________
11. Remove lockout device and turn power back on according to established shop procedures.	________	________

Approved: Yes ____ No ____

Evaluator's Signature Date

DUTY: PERFORMING DRILL PRESS OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 134

TASK: Counterbore to depth with drill press.

CONDITIONS: A metal workpiece with pilot hole, blueprint specifications, lubricants and the following tools and equipment:

Counterbores
Drill press with accessories
Holding device
Machinery's handbook or table for selecting counterbore/speeds/feed
Personal safety equipment
Rule depth gage
Table clamps
Workpiece (with pilot hole).

STANDARD: When completed, the size, depth and concentricity of the counterbore must be within specifications.

SOURCE FOR STANDARD:

Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook,** 21st ed., pp. 1670-1671.

PERFORMANCE GUIDE

1. Verify material, if necessary, for counterbore selection, cutting speed and feed.
2. Select/mount counterbore to fit pilot hole.
3. Secure workpiece in holding device and clamp to table.
4. Align counterbore with pilot hole in workpiece.
5. Select/set speed control/start drill press.
6. Counterbore hole to specified depth. Lubricate as necessary.
7. Turn off drill press.
8. Check counterbore for accuracy.
9. Remove counterbore.
10. Remove workpiece.

ENABLING OBJECTIVES

Use personal safety rules.
Use drill press safety rules.
Use measuring tools.
Use holding devices.
Use of charts and tables for speeds and feeds.
Identify cutting tools.
Read a blueprint.
Interpret vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 134

LEARNING ACTIVITIES

1. Read chapter on drill presses and drill press operations. Write answers to all questions at end of chapter.
2. Participate in classroom discussion on drill press operations. (Reference material - student handout and written homework).
3. Attend a lecture on drill press operations (drilling and counterboring). Participate in question and answer period at end of presentation.
4. Measure pilot hole, select and mount proper pilot on counterbore.
5. Measure pilot hole, make a suitable pilot for a counterbore.
6. Attend a demonstration of counterboring to specific depth. Observe three methods of setting proper depth.
   a. Cut and check. Slowest and subject to operator error. Very accurate once set however.
   b. Set depth stop with scale. Cut and try. Adjust as necessary. Slow and subject to operator error but quicker than straight cut and try.
   c. Set depth stop with gage block(s). Most accurate and quickest but all pieces must be same thickness.
7. Practice setting counterbore to cut a specific depth using the three different methods demonstrated by instructor.
8. Attend a demonstration of how to counterbore a hole without using a pilot. Practice this method under instructor guidance.
9. Read and discuss information sheets on Counterboring, Countersinking and Spot Facing - Appendix # 1.
10. Practice counterboring on a drill press under instructor supervision.
11. Read and discuss information sheets on Drilling, Reading and Honing - Appendix #J.

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setup,"** chapter 5, **"Drill Press: Types, and Operations,"** Chapter 2, pp. 106-150, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Johnson, Harold V., **"General Industrial Machine Shop,"** Section 6, **"Producing Cylindrical Holes,"** Unit 55, 56, 57, pp. 331-354. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measuring and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Olivo, et al. **Basic Blueprint Reading and Sketching.** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Ronan, William. **Home and Shop Safety Series: "Personal Safety," "Power Tool Safety."**

Starrett, **Tools and Rules for Precision Measuring,** pamphlet, pp. 13-15, 17-23, 56-58.

Rockwell Intl., **Nomenclature Chart with Safety Suggestions.**

Information sheet Appendix I (Counterboring and Countersinking and Spot Facing), vocabulary - information sheet, information sheet appendix J (Drilling, Reaming and Honing).

PERFORMANCE OBJECTIVE V-TECS 134

EVALUATION

Questions

1. Describe in detail at least two different methods for accurately setting the depth for a counterbored hole.
2. Why is an accurately sized pilot necessary for counterboring operations?
3. What is the purpose of a counterbored hole?
4. What is the difference between a counterbore and a countersink?
5. How does a counterbore differ from an end mill?

Answers

1. Describe at least two ways to accurately set the depth for a counterbore.
   a.
   1). Mount counterbore in drill press and align spindle with hole in workpiece.
   2). Clamp workpiece to table.
   3). Bring bottom of counterbore into contact with the surface of the workpiece. Lock spindle at this position.
   4). Using a gage block, carefully set the depth on the depth stop.
   5). Lock depth stop in position, remove gage block, and release spindle.
   6). Turn on machine and counterbore to depth stop. Spindle will stop at gage setting.
   7). Remove counterbore and check depth with a depth micrometer or depth gage.
   8). Remove from machine and clean oil and chips and deburr to complete. Make final check of depth before moving on.

   b.
   1). Mount counterbore in spindle and align hole in workpiece with spindle.
   2). Clamp workpiece to table.
   3). Rough cut depth using a scale for reference.
   4). Set depth stop on machine to this setting and move cutter or workpiece so that an accurate measurement can be taken.
   5). Measure depth and adjust stop on machine and realign workpiece hole and recut.
   6). Again move the workpiece and make a final check of depth.
   7). Reset and recut again until correct depth is reached.
   8). Remove workpiece, clean off oil and grease and deburr. Make final check of depth to complete.
2. If the pilot is not of correct diameter the c/bore will not be concentric with the hole.
3. Counterbored holes provide a cavity for the head of a bolt or screw to fit in so that it does not stick up above the surface of the workpiece.
4. A counterbore enlarges one end of a hole to a specific diameter and depth.
   A countersink makes a cone shaped enlargement at one end of a hole suitable for a flat head screw.

Evaluation Continued

5. The major difference between a counterbore and an end drill is the way they are ground. An end mill is ground with a slight taper along its peripheral edges and the bottom is cupped. A counterbore is ground straight along its peripheral edges and the bottom is ground flat.

DUTY: PERFORMING DRILL PRESS OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 135

TASK: Countersink with drill press.

CONDITIONS: A metal workpiece with hole to be countersunk, specifications, lubricants and the following tools and equipment:

Countersinks
Drill press with accessories
Holding device
Machinery's handbook
Personal safety equipment
Table clamps.

STANDARD: When completed, the surface must be smooth and free from burrs and chatter marks, and concentic with hole in accordance with specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 1640-1641, 1962.

PERFORMANCE GUIDE

1. Verify workpiece material for countersink selection and cutting speeds/feeds.
2. Select/mount countersink.
3. Secure workpiece in holding device/clamp to table.
4. Align countersink with hole in workpiece.
5. Select/set speed.
6. Start drill press.
7. Countersink hole. Lubricate as necessary.
8. Turn off drill press.
9. Check countersink in accordance with specifications.
10. Remove countersink.
11. Remove workpiece.

ENABLING OBJECTIVES

Use personal safety rules.
Use drill safety press rules.
Use measuring tools.
Use holding devices.
Use of charts and tables for speeds and feeds.
Identify cutting tools.

Enabling Objectives Continued

Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Review chapter on drill presses and drill press operations in Machine Shop Operations and Setup, pp. 106-180.
2. Participate in classroom discussion on drill press operations. (Reference material - student handout and written homework).
3. Review information sheet on Counterboring, Countersinking and Spot Facing - Appendix I.
4. Attend a demonstration of countersinking. Observe three methods of setting proper depth.
   a. Cut and check. Slowest and subject to operator error. Very accurate once set however.
   b. Set depth stop with scale. Cut and try. Adjust as necessary. Slow and subject to operator error but quicker than straight cut and try.
   c. Set depth stop with gage block(s). Most accurate and quickest but all pieces must be same thickness.
5. Practice setting countersink to cut a specific depth using the three different methods demonstrated by instructor.
6. Practice countersinking on a drill press under instructor supervision.

RESOURCES

Lasco, et al. **Machine Shop Operations and Setups.** Chapter 5, **"Drill Presses: Types, Setups, and Operations,"** pp. 106-150. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Johnson, Harold V., **General Industrial Machine Shop.** Section 6, **"Production Cylindrical Holes."** Units 55, 56, 57, pp. 331-354. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Olivo, et al. **Basic Blueprint Reading and Sketching.** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Ronan, William. **Home and Shop Safety, "Personal Safety," "Power Tool Safety."**

Starrett, **Tools and Rules for Precision Measuring,** pamphlet, pp. 13-15, 17-23, 56-58.

Rockwell Intl. **Nomenclature Chart with Safety Suggestions.** Information sheet Appendix I (Counterboring, Countersinks and Spot-Facing).

EVALUATION

Questions

1. What is a countersink?
2. What is the purpose of a countersink hole?

Evaluation Continued

3. What is the difference between a countersink and a counterbore?
4. What is the correct angle on a countersink for a flat head screw?
5. List some of the angles which countersinks can be purchased.

Answers

1. A countersink is a cutting tool used to make a cone shaped enlargement at one end of a hole, usually to allow a flat head screw to fit flush with the surface.
2. The most common use of a countersink hole is to allow a flat head screw to fit flush with the surface of the part. Another use is to chamfer the edge of a hole.
3. A counterbore enlarges one end of a hole to a specific diameter and depth.
4. 82 degrees. This is the industry standard for flat head screws and bolts.
5. 110 degrees, 100 degrees, 90 degrees, 82 degrees, 60 degrees, and 30 degrees. Others are available on special order.

DUTY: PERFORMING DRILL PRESS OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 136

TASK: Drill hole to size with drill press.

CONDITIONS: A metal workpiece, lubricants, blueprint/specifications and the following tools and equipment:

Center punch
Chuck wrench
Deburring tool
Drill size gage
Inside - outside dial vernier caliper
Machinery's handbook or drilling speed/feed/drill tables
Micrometer
Personal safety equipment
Prick punch
Scribe
Set of drills
Small hole gages
Table clamps or holding device.

STANDARD: When completed, the hole(s) must have smooth finish within accuracy of +0.005" of normal drill size and locate with ±0.010" of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 1656-1670, 1749.

PERFORMANCE GUIDE

1. Verify workpiece material for selection of drill/speed/feed.
2. Verify specifications for size/type of hole (through or blind hole).
3. Lay out holes with scribe, prick punch, recheck location.
4. Center punch.
5. Select/mount pilot drill in chuck. Check condition of drill.
6. Secure workpiece in holding device/clamp to table.
7. Select/set speed.
8. Pilot drill. Recheck location.
9. Stop drill press.
10. Remove pilot drill.
11. Select/mount drill in chuck. Check condition of drill. Step/drill and reset speed/feed as necessary.
12. Select/set speed. Final drill. Lubricate as necessary.
13. Turn off drill press.
14. Remove drill.
15. Remove workpiece.
16. Deburr as necessary.

PERFORMANCE OBECTIVE V-TECS 136

ENABLING OBJECTIVES

Use personal safety rules.
Use drill safety press rules.
Drill press orientation.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for speeds and feeds.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Review chapter on drill presses and drill press operations in **Machine Shop Operations and Setups,** pp. 106-150.
2. Participate in classroom discussion on drill press operations. (Reference material - student handout and written homework).
3. Observe presentation by instructor of proper procedures for setting up, drilling, and deburring drilled holes.
4. Observe presentation by instructor or other demonstrator showing proper methods for drilling very accurate sized holes.
5. Review informations sheet on **Drilling, Repairing and Honing**- Appendix J.
6. Practice lay out, set up, and drilling of holes using a drill press under instructor supervision.
7. Lay out, set up, and drill holes to size specified. Have instructor inspect work for size and location accuracy.
8. Practice drilling very accurate holes (size and location) using techniques demonstrated.

RESOURCES

Lasco, et al. **Measuring Shop Operations and Setups.** Chapter 5, **"Drill Presses: Types, Setups, and Operation,"** pp. 106-150. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Johnson, Harold V. **General Industrial Machine Shop.** Section 6, **"Production Cylindrical Holes,"** Units 55, 56, 57, pp. 331-354. Section 6, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Olivo, et al. **Basic Blueprint Reading and Sketching.** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Ronan, William. **Home and Shop Safety Series, "Personal Safety," "Power Tool Safety."**

Starrett, **Tools and Rules for Precision Measuring,** pamphlet, pp. 13-15, 17-23, 56-58. Information Sheet Appendix J (Drilling Reaming, and Honing).

PERFORMANCE OBJECTIVE V-TECS 136

EVALUATION

Questions

1. Why should all hole locations be center punched before drilling? List at least two.
2. A tool called a ____________ is used to deburr holes and give them a nice looking edge.
3. What is the purpose of hold downs?
4. What is the probable cause of a drill bit cutting oversize?
5. Why is a properly ground drill bit important when drilling plastics or brass?
6. Why is it a good idea to drill a pilot hole before drilling a hole to final size?

Answers

1. a. Provides a place for the point on a drill bit to start. Without it, the point of the drill bit might "walk" away from the proper location.
   b. Clearly marks the spot where a drilled hole is to be located even if layout dye is wiped off.
   c. Provides an indentation for the point on a divider for scribing circles and other locating points on lay out work.
2. Countersink. Other answers which may be acceptable - 3 cornered scraper, burr-quick.
3. Hold downs are used to hold the workpiece securely in the drill press. The term is also used to describe a special type of clamp used on shapers and planers for the same purpose.
4. The most probable cause of a drill cutting oversized is that the point is ground off center. This commonly happens when drill bits are off-hand ground by the mechanic. It can be corrected by machine grinding a new point on the drill. Other causes include a burr kicked on the flutes, metal chips welding to the flutes due to insufficient lubrication.
5. An improperly ground drill bit will grab in the material causing the workpiece to ride up on the drill or causing the drill bit to gouge into the material. By slightly dulling the cutting edge on the point this can be prevented when cutting brass and some plastics.
6. The point of a drill will follow the path of least resistance. If there is no pilot hole the drill may walk off a true line in a deep cut. The pilot hole gives the larger drill a path to follow. Of course the pilot must be straight and accurately located.

DUTY: PERFORMING DRILL PRESS OPERATION

PERFORMANCE OBJECTIVE V-TECS 137

TASK: Hone hole with drill press.

CONDITIONS: A steel workpiece with hole to be honed, specifications for honing, lubricant and the following tools and equipment:

Chuck wrench
Drill press with accessories
Holding device
Hones
Machinery's handbook
Outside micrometer
Personal safety equipment
Small hole gages/pin gages
Table clamps
Telescoping gage.

STANDARD: When completed, hole must have smooth finish, and the size must be within tolerance of specifications or Total Inch Runout (T.I.R.) of 0.0005".

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Check rough size and condition of hole.
2. Determine finished size of hole to be honed.
3. Select/chuck hone.
4. Align hone with hole in workpiece.
5. Secure workpiece in holding device/clamp to table. Recheck alignment.
6. Select speed/set speed control/start drill press.
7. Hone hole to specifications. Lubricate as needed.
8. Turn off drill press.
9. Clean hole.
10. Check size of hole with gage.
11. Remove hone from chuck.
12. Remove workpiece from table.

ENABLING OBJECTIVES

Use personal safety rules.
Use drill press safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.

PERFORMANCE OBJECTIVE V-TECS 137

Enabling Objectives Continued

Use charts and tables for speed and feeds.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Review chapter on drill presses and drill press operations in Machine Shop Operations and Setup, pp. 106-150.
2. Participate in classroom discussion on drill press operations. (Reference material - student handout, written homework).
3. Attend a lecture/demonstration on drill press operations (honing). Participate in question and answer period at end of presentation.
4. Review information sheets on Drilling, Reaming and Honing - Appendix J.
5. Lay out and drill holes to prepare for honing practice.
6. Practice honing procedures with instructor assistance.
7. Use commercial hones to clean up cylinder bores or other available practice jobs.
8. Make several simple honing tools from brass, aluminum or wood.
9. Working from a blueprint, lay out, center punch, drill rough diameter holes. Set up on drill press and hone holes to print specifications. (Make a simple hone if necessary). Present to instructor for evaluation.

RESOURCES

Lasco, et al. **Machine Shop Operations and Setups.** Chapter 5, **"Drill Presses: Types, Setups, and Operations,"** pp. 106-150. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.
Johnson, Harold V. **General Industrial Machine Shop.** Section 6, **"Producing Cylindrical Holes,"** Units 55, 56, 57, pp. 331-354. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Unit 13, 14, 15,16, 17, pp. 83-129.
Olivo, et al. **Basic Blueprint Reading and Sketching.** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Ronan, William. Home and Shop Safety Series, **"Personal Safety," "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.
Rockwell Intl., Nomenclature Chart with Safety Suggestions.
Information Sheet - Appendix J - (Drilling, Reaming and Honing).

PERFORMANCE OBJECTIVE V-TECS 137

EVALUATION

Questions

1. What is a hone?
2. Why hone a hole?
3. Describe the steps to be followed when honing a hole.
4. How much material should be left in a hole prior to honing?
5. Describe "bell mouth." How can this condition be prevented when honing?

Answers

1. A hone is a tool used to produce a very smooth, accurate, and straight hole. Hones come in two different styles:
   a. A spring loaded device with legs containing fine emery stones which can be pushed back and forth through a hole while rotating. Best example of this sort is a glaze breaker and cylinder hone used in automotive work and small engine repair.
   b. A precision turned plug type tool made of aluminum or brass (or similar soft material) impregnated with emery or diamond dust. The grit may also be applied in a grease as an additive to the softer material of the hone. This type is often shop made and very inexpensive.
   c. A special type of tool consisting of a frame containing one or more adjustable stones and at least one wiper. The stones are adjusted and then locked in position and the hone passed through the hole. The stones are adjusted until the correct diameter is reached.
2. A hole should be honed when it is to be used as a bearing surface (as in a sleeve bearing). It should be honed when it is to be used as a way of injecting pressurized air or liquids into chambers (as in fuel jets). It should be used wherever you want a smooth sliding fit between parts, etc.
3. NOTE: Honing can be done using two different kinds of tool.

   TYPE 1: The commercially available honing tool which consists of a frame with 1 or 2 stones and wipers. The diameter of this device can be adjusted as the hole size is increased thus providing an easy way to size holes which also require a smooth, straight finish.

   Type 2: The shop made tool which consists of a turned plug made of aluminum, brass, or other material soft enough so that an abrasive material (such as fine lapping compound) can be pressed into the surface of the hone.
   a. Use the same speed or slightly faster for honing.
   b. Select a proper size hone or custom make your own from aluminum or brass. Mount in machine chuck.
   c. Apply a quantity of lapping compound to the hone and slowly push the rotating tool through the hole. Back up and push through again. Do this several times and then stop. Remove the tool and clean the workpiece and check the hole for size and finish. If now correct you may remove the workpiece from the machine and deburr. If not correct then replace the tool and adding more compound continue honing until size and finish are correct.

Evaluation Continued

   d. Remove workpiece from the machine and deburr and move on to the next operation.

4. You should leave no more than .001 to .002 for honing. Remember, you are only using emery grit or diamond dust to do your cutting. These materials do not remove much material. Honing is not reaming though reaming undersized and then honing is an excellent way to produce extremely accurate holes.
5. Bell-mouth is common in holes where the automotive type hone is used. Bell-mouth is where the very end of the hole, usually the top, comes out a little bigger than the rest of the hole. Think of the shape of a bell. This condition can be prevented by using rigid type hones, held in machine chucks, rather than by hand. Keep your applications of compound to a minimum so that there are no large buildups at top of hole when hone first enters hole. Check often. Be sure to measure the diameter at each end and several places between. If only .001 to .002 was left bell-mouth will not be a problem.

DUTY: PERFORMING DRILL PRESS OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 138

TASK: Ream holes to size with drill press.

CONDITIONS: A metal workpiece with drilled hole(s), specifications, lubricants and the following tools and equipment:

Chuck wrench
Drill press with accessories
Machinery's handbook or tables for reaming sizes/speeds/feeds
Personal safety equipment
Plug gage (go-no go)
Set of drills
Set of reamers
Table clamps.

STANDARD: When completed, the hole(s) must have smooth finish and snug fit on "Go" portion of plug with a Total Inch Runout (T.I.R.) of 0.0001" maximum.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook,** 21st ed., pp. 1635-1654, 1749-1785.

PERFORMANCE GUIDE

1. Verify workpiece material for selection of reamer and cutting speed/feed.
2. Check size of hole.
3. Align hole with drill in chuck.
4. Secure workpiece in holding device/clamp to table.
5. Select/mount reamer.
6. Select/set speed.
7. Ream hole. Lubricate as necessary.
8. Remove reamer from hole.
9. Stop drill press.
10. Remove workpiece.
11. Wipe off lubricant from workpiece.
12. Check size of reamed hole to specifications.

ENABLING OBJECTIVES

Use personal safety rules.
Use drill press safety rules.
Use measuring tools.
Use layout tools and techniques.

PERFORMANCE OBJECTIVE V-TECS 138

Enabling Objectives Continued

Use holding devices.
Use charts and tables for speeds and feeds.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Review chapter on drill press and drill press operations in Machine Shop Operations and Setup, pp. 106-150.
2. Participate in classroom discussion on drill press operations. (Reference material - student handout, written homework).
3. Attend a lecture/demonstration on drill press operations (Reaming). Participate in question and answer period at end of presentation.
4. Review information sheets on Drilling, Reaming, and Honing, Appendix J.
5. Lay out and drill undersize holes to prepare for reaming practice.
6. Practice reaming procedures with instructor assistance.
7. Use reamers to accurately size predrilled holes to print specifications.
8. Working from a blueprint, layout, center punch, drill rough diameter holes. Set up on drill press and ream holes to print specifications. Present to instructor for evaluation.

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 5, **"Drill Press: Types, Setups, and Operations,"** pp. 106-150. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Johnson. **"General Industrial Machine Shop."** Section 6, **"Producing Cylindrical Holes,"** Units 55, 56, 57, pp. 331-334. Section 1, **"Introduction to Machine Shop Practices,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Ronan, William. Home and Shop Safety Series **"Personal Safety," "Power Tools Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Information Sheet - Appendix J (Drilling, Reaming and Honing).

EVALUATION

1. Explain the difference between drilling and reaming.
2. Which method is more accurate for sizing holes, drilling or reaming? Explain your answer?
3. What happens if you leave too much material in a hole to be reamed out?
4. List four different types of reamer and describe the use of each.
5. Reaming is as good as honing for producing smooth, straight holes. Explain why you agree or disagree with this statement.

Answers

1. Drilling is the process of cutting a round hole into or through a workpiece.
   Reaming is a process of accurately sizing an already existing hole.
2. Reaming: Drilling produces a hole which may or may not be accurate for size. To produce truly accurate sized holes, they should be reamed. Reamers are accurately ground on their periphery. They cut on this outside surface rather than on the end like a drill. A reamer requires lots of coolant/lubricant because of the large cutting area of the flutes. Because reamers cut on their diameter, not on the bottom they can be ground to exact sizes. They have many cutting edges, not just two like a drill.
3. Reamers are classified into many different types. Some can remove relatively large amounts of stock, while others work better removing a small amount of material. A hole with too much material for the reamer selected to remove will probably come out oversized. The reamer has little clearance between its cutting edges so space for chips to gather is limited. Once the chips pack up in the reamer they might cause the reamer to cut big, or worse, cause the reamer to bind and maybe break. A good rule to follow is to leave no more than .010 in a hole to be reamed.
4. Rose reamer: Has fewer teeth than the machine reamer and cuts on the leading edge of the teeth. Used for removing heavier amounts of stock.
   Fluted machine reamer: Has many flutes (cutting edges) and is ground to cut primarily on the sides rather than on the end like a rose reamer. Because of the many teeth, only small amounts of material should be cut with this type of reamer.
   Hand reamer: As its name implies, this type of reamer is used by hand. Used when extremely accurate fitted holes are needed. They require much skill on the part of the mechanic. They remove the least amount of stock.
   Expansion reamers: These are a special type which can be adjusted to any size within the limits of their range. They are used to produce accurate holes where nothing is standard sized - the every sized reamer.

Evaluation Continued

5. Disagree: Reaming can produce smooth straight holes, this is true only within the availability of cutter size and operator skill at using reamers. Reamers are primarily a cutting tool. A hone is more a polishing tool since it removes such a small amount of stock. Hones are designed to produce highly polished, straight, smooth holes. Accuracy is also much more accurate.

DUTY: PERFORMING DRILL PRESS OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 139

TASK: Spot-face hole with drill press.

CONDITIONS: A metal workpiece with pilot hole, specifications for spot-face lubricants and the following tools and equipment:

Chuck wrench
Machinery's handbook
Personal safety equipment
Spot-facer (counterbore)
Table clamps.

STANDARD: When completed, the spot-face will be smooth, free of chatter marks, true, and concentric with pilot hole according to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Check size of pilot hole.
2. Select counterbore.
3. Chuck spot-facer (counterbore).
4. Align spot-facer with pilot hole.
5. Secure workpiece in holding device/clamp to table. Check alignment.
6. Select speed/set speed control/start drill press.
7. Spot-face hole to specifications. Lubricate as necessary.
8. Stop drill press.
9. Remove spot-facer (counterbore).
10. Remove workpiece.
11. Wipe off excess lubricant.
12. Check spot-face with specifications.

ENABLING OBJECTIVES

Use personal safety rules.
Use drill press safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for speeds and feeds.
Read a blueprint.
Interpret vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 139

LEARNING ACTIVITIES

1. Review chapter on drill presses and drill press operations in Machines Operations and Setup, pp. 106-150.
2. Participate in classroom discussion on drill press operations. (Reference material - student handout, written homework).
3. View a movie on drill press operations. (Spot-facing)
4. Attend a lecture/demonstration on drill press operations (spot-facing). Participate in question and answer period at end of presentation.
5. Observe a demonstration of the proper method of using a counterbore to produce a spotface on a workpiece.
6. Information Sheet on Counterboring, Countersinking and Spot-Facing, Appendix I.
7. Lay out and drill holes to prepare for spot-facing practice.
8. Practice spot-facing procedures with instructor assistance.
9. Practice spot-facing with counterbores using drill press.
10. Working from a blueprint, lay out, center punch, drill holes, set up on drill press and spot-face to print specifications. Present to instructor for evaluation.

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 5, **"Drill Press: Types, Setups, and Operations,"** pp. 106-150. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Johnson. **"General Industrial Machine Shop."** Section 6, **"Producing Cylindrical Holes,"** Units 55, 56, 57, pp. 331-354. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

Rockwell Intl,. **"Nomenclature Chart with Safety Suggestions."**

Information Sheet - Appendix I (Counterboring, Countersinking and Spot-Facing).

EVALUATION

Questions

1. What is a spot-face?
2. In what ways are spot-facing and counterboring similar?
3. A counterbore may be used for spotfacing. Explain why?
4. What is the primary purpose of spot-facing?
5. Why should an end mill never be used for spot-facing?

Evaluation Continued

Answers

1. A spot face is an area which is cut perfectly flat, usually concentric with a bolt hole (most commonly on castings) for the purpose of providing a flat, true surface for the clamping action of a bolt and washer combination.
2. Spot-Facing and counterboring use the same tool (the counterbore/w pilot). The set up is the same as well as the exact same procedures. The major difference is that a spot-face is seldom more than 1/32 deep.
3. A counterbore has a pilot attached which allows the operator to exactly center his cutter by selecting the correct sized pilot. A counterbore has a perfectly flat ground bottom cutting face which will produce the desired flat surface around the hole.
4. The primary purpose of a spot-face is to provide a flat true surface around a hole (usually in castings) so that a bolt and washer can lay flat against the surface thus providing the maximum strength to the bolted assembly.
5. An end mill should never be used to spot-face for two reasons. First, the bottom of most end mills are not ground flat. They are slightly cupped thus any surface cut with one used as a spotface would not be flat, but crowned at the hole. The second reason is that it is unsafe to use any end mill in a drill press for any reason. They are quite sharp and, unless the piece is securely clamped, they will grab it. Also, great care must be taken to accurately center the cutter since it has no pilot.

DUTY: PERFORMING DRILL PRESS OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 140

TASK: Tap hole with drill press.

CONDITIONS: A workpiece with drilled hole, specifications, lubricant and the following tools and equipment:

Allen wrench
Holding device
Machinery's handbook
Personal safety equipment
Square
Table clamps
Tap and tapping chuck
Thread gages (go-no go).

STANDARD: When completed, the threads must be at specified depth, free of burrs and chatter marks, and fit go-no go thread gage within specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 1383-1430.

PERFORMANCE GUIDE

1. Select tap (plug type for through holes, bottoming tap for blind hole).
2. Chuck tap.
3. Select speed/set speed control/start drill press.
   NOTE: Tap may be started by hand.
4. Align tap with hole in workpiece.
5. Secure workpiece in holding device/clamp to table.
   Recheck alignment.
6. Lubricate tap.
7. Tap hole. Lubricate as necessary.
8. Remove tap.
9. Remove workpiece.
10. Clean threads in tapped hole.
11. Check threads with thread gage.

ENABLING OBJECTIVES

Use personal safety rules.
Use drill press safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for speeds and feeds.
Threads and threading.

PERFORMANCE OBJECTIVE V-TECS 140

Enabling Objectives Continued

Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Review chapter on drill presses and drill press operations in Machine Operations and Setups, pp. 106-150.
2. Participate in classroom discussion on drill press operations. (Reference material - student handout and written homework).
3. View a movie on drill press operations (Tapping).
4. Attend a lecture presentation on tapping on a drill press. Participate in question and answer period at end of presentation.
5. Read and discuss Information Sheet on Tapping - Appendix R.
6. Observe presentation by instructor of proper procedures for setting up, tapping, and deburring tapped holes.
7. Observe presentation by instructor or other demonstrator showing proper methods for tapping holes.
8. Practice set up, and tapping of holes using a drill press under instructor supervision.
9. Lay out, set up, and drill and tap holes to specified fit and depth. Have instructor inspect work for size, location, and depth accuracy.
10. Practice tapping holes in a variety of materials both metallic and plastic. Practice drilling through and to specific depths. Practice making pipe tapped holes.

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 5, **"Drill Presses: Types, Setups, and Operations,"** pp. 106-150. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.
Johnson. **"General Industrial Machine Shop."** Section 6, **"Production Cylindrical Holes,"** Units 55, 56, 57, pp. 331-354. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.
Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.
Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**
Information Sheet - (Tapping) Appendix K.

PERFORMANCE OBJECTIVE V-TECS 140

EVALUATION

1. Describe two ways commonly used to perform tapping in a drill press.
2. What is a tapping center?
3. Why are gun or spiral fluted taps better suited to tapping in a drill press?
4. What is one advantage of tapping using a drill press to drive the tap?
5. What is one disadvantage of using a drill press to drive a tap?

Answers

1. General requirements for both procedures.
    a. Carefully lay out the hole location(s) on the workpiece, center punch and scribe a reference circle at each location.
    b. Set up on drill press, align center punch with center spindle, clamp workpiece.
    c. Refer to tapping charts and select the proper tap drill. (A drill selected to leave sufficient material in the hole to produce a 75 percent or greater full thread).
    d. Spot with center drill and check to assure proper alignment.
    e. Mount the tap drill and drill the hole to proper depth or through as required.

Procedure 1 by hand, on the drill press or other machine:

a. After drilling the proper sized tap drilled hole do NOT remove the workpiece from the machine. Leave the clamps in place.
b. Remove the drill from the chuck and insert a tool called a tapping center. (A ground pointed tool used to support the end of the tap while it is turned by the mechanic. It may be a solid piece or it may be spring loaded or both).
c. Engage the point of the center either with the tap or the "T" handled tap wrench, for support.
d. Keeping pressure on the center, slowly turn the tap into the piece 1/2 turn. Release pressure and back off slightly to break the chip. Continue this procedure until tap cuts through the piece or until proper depth is reached. Remember the tap may have to be removed several times to remove chips from a blind hole.
e. Move on to next hole and repeat entire operation from Procedure 1, step a.
f. Remove from the machine, deburr and clean all chips, grease and oil to complete.

Procedure 2 by machine:

a. After drilling proper size holes remove the drill and drill chuck.
b. Do not move your workpiece or remove any clamps.
c. In place of the drill chuck install a device called a tapping head. This is a special tool designed to drive a tap through a workpiece. It contains a set of gears to reverse the rotation of the tap and a slip clutch to disengage the drive should the tap become stuck. Another type of device is simply called a tap driver. This is simply a chuck designed to hold a tap. It has no provision for reversing or slip clutch.

Evaluation Continued

d. Mount your tap in whatever device you are going to use to drive the tap.
e. SLOW down the spindle speed and start the spindle.
f. Press the tap into the hole firmly, using the quill on the machine. Keep the pressure on until tap cuts through the piece. If you are tapping a blind hole, set a stop or other device so that you know when to release pressure or stop the machine.
g. Reverse the machine and back the tap out. Clear all chips and check for proper fit and depth.
h. Move on to next hole and repeat from step 1a.
i. Remove from the machine, deburr and clean all grease and oil to complete.

NOTE: It is not recommended that tapping by machine be attempted in blind holes without the proper type of tap driver and proper training and experience given to the machine operator. (Taps break and are expensive).

2. A tapping center is a precision ground, pointed tool, which may or may not be spring loaded. It is mounted in a drill chuck and used to keep the top or "T" handled tap wrench perpendicular to the surface of the workpiece while tapping.
3. Spiral fluted or gun taps cause the chip to curl out of the hole rather than curling tightly into the flute as it does in a conventional tap. Less likely to cause breakage when driven through a hole by machine.
4. The major advantage of using a drill press or other source of power when tapping is speed. Lots of holes tapped in much faster time than by hand.
5. A major disadvantage is that an experienced operator is required for most powered tapping operations. If the hole is blind (not drilled through) it requires some skill at stopping at the proper place so that the tap will not be broken. It is not recommended that blind holes be tapped by inexperienced operators.

DUTY: PERFORMING DRILL PRESS OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 141

TASK: Bore hole with boring head on drill press.

CONDITIONS: A metal workpiece with pilot hole, specifications for bored hole and the following tools and equipment:

Allen wrench
Boring head
Drill press with accessories
Holding device
Inside - outside dial vernier caliper
Outside micrometer
Personal safety equipment
Table clamps
Telescoping gage
Tool bit (high speed).

STANDARD: When completed, the bored hole must have smooth finish of T.I.R. of .001" maximum and the size must be within specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook,** 21st ed., p. 292.

PERFORMANCE GUIDE

1. Identify workpiece material for tool bit selection, cutting speed and feed.
2. Select tool bit. Sharpen if necessary.
3. Install tool bit in boring head.
4. Secure workpiece in holding device/clamp to table.
5. Select speed/feed.
6. Set tool bit to bore hole.
7. Start drill press (speed control).
8. Start boring feed manually.
9. Engage drill press feed control.
10. Bore hole. Make roughing cuts as needed.
11. Disengage feed control.
12. Stop drill press (speed control).
13. Measure hole size.
14. Remove tool bit boring head.
15. Remove workpiece.

PERFORMANCE OBJECTIVE V-TECS 141

ENABLING OBJECTIVES

Use personal safety rules.
Use drill press safety rules.
Use measuring tools.
Use holding devices.
Use charts and tables for speeds and feeds.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Review chapter on drill press and drill press operations in Machine Shop Operations and Setup, pp. 106-150.
2. Participate in classroom discussion on drill press operations. (Reference material - student handout and written homework).
3. Attend a lecture presentation on drilling on a drill press. Participate in question and answer period at end of presentation.
4. Observe presentation by instructor of proper procedures for setting up, drilling, and deburring drilled holes.
5. Observe presentation by instructor or other demonstrator showing proper methods for drilling very accurate sized holes.
6. Practice lay out, set up, drilling and boring of holes using a drill press under instructor supervision.
7. Lay out, set up, and drill holes to size specified. Have instructor inspect work for size and location accuracy.
8. Practice drilling very accurate holes (size and location) using techniques demonstrated.

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 5, **"Drill Presses: Drill Presses: Types, Setups, and Operations,"** pp. 106-150. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.
Johnson. **"General Industrial Machine Shop."** Section 6, **"Production Cylindrical Holes,"** Units 55, 56, 57, pp. 331-354. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, p. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.
Olivo, et al. **"Basic Blueprint and Reading Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.
Rockwell Intl. "Nomenclature Chart with Safety Suggestions."

PERFORMANCE OBJECTIVE V-TECS 141

EVALUATION

Questions

1. What is boring?
2. Why should boring never be attempted on a machine without power feed?
3. How is boring different from reaming?
4. Why is boring better for making smooth straight holes than reaming?
5. A pilot hole is necessary for boring. (True or False)

Answers

1. Boring is the process of enlarging and truing a hole with a single point tool. Unlike the reamer, the boring tool is independent of irregularities in the drilled hole.
2. Attempting to move a boring tool through a hole without a power feed is dangerous. The single point tool will snag in the work because there is no way to prevent it. The result will be a broken tool, and a ruined workpiece. You cannot move as slowly or with the necessary control to even attempt to bore by hand feed. This should not be attempted at all.
3. A boring tool has a single cutting point and cuts on that single point as it rotates, thus allowing the tool to follow its own line instead of having to follow a drilled hole. A reamer has many cutting edges and will follow a drilled hole and simply size it. A reamer will not relocate a hole that has drifted.
4. A reamer follows a drilled hole and is subject to the irregularities in the material or the drilled hole itself. Drilled holes are seldom straight. Boring tools, on the other hand, do not need to follow the predrilled hole. In fact, boring is the best way to straighten a crooked hole or to relocate a hole which may have drifted out of position during the drilling operation.
5. True

PERFORMING GRINDING OPERATIONS

DUTY: PERFORMING GRINDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 142

TASK: Clean and lubricate grinding machines.

CONDITIONS: A grinding machine, lubricants and the following tools and equipment:

Grease gun
Lock
Maintenance mechanic's tool box (hand tools)
Manufacturer's manual
Oil cans
Personal safety equipment
Wiping rags.

STANDARD: When completed, machined/sliding/finished surfaces must be clean and free of grit and dirt. Oil level gages must show "full." All grease fittings and oil points must be lubricated according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Turn off/lock out grinder power.
2. Consult manufacturer's manual for lubrication specifications/locations.
3. Disassemble as necessary.
4. Wipe clean all machined finished surfaces (ways, slides, etc.). Check for wear.
5. Locate/wipe clean lubrication points/grease fittings according to manufacturer's manual.
6. Select lubricants.
7. Fill oil reservoirs.
8. Lubricate grease fittings.
9. Check oil level gages.
10. Wipe off excess lubricants as necessary. Check for and remove grit on sliding surfaces.
11. Reassemble as necessary. If system has automatic lubrication and feed, check to see that all lines are open before assembling.
12. Unlock power.

ENABLING OBJECTIVES

Use safety procedures when working with electricity.
Use standard procedures for general maintenance of equipment.
Identification of grease and oil fittings.
Determine lubricant.
Use standard preventive maintenance procedures and techniques.

PERFORMANCE OBJECTIVE V-TECS 142

LEARNING ACTIVITIES

1. Read handbook on electrical safety. Write a complete description of the proper procedures for electrical safety when working on any powered equipment.
2. Attend a lecture on electrical safety given by representative speaker from local power company.
3. Participate in class discussions of safety practices to be followed at all times.
4. Practice lockout procedures on various types of equipment.
5. Read manufacturer's manual concerning general maintenance of the equipment. Describe the standard procedures recommended for general care of the equipment. Read section concerning lubrication and select the proper lubricants for the equipment. Explain reason for selections.
6. Read textbook section on preventive maintenance procedures in General Industrial Machine Shop, pp. 19-24. Write answers to questions at end of section.
7. Participate in class discussion on preventive maintenance procedures commonly followed in industrial plants.
8. Attend a lecture/demonstration given by a representative speaker from a local industrial maintenance shop or department.
9. Tour an industrial plant with the maintenance supervisor. Discuss why and how of maintenance procedures.
10. Read section on lubrication in textbook in Industrial Maintenance, pp. 56-64 and answer questions at end of section.
11. Practice lubricating all types of equipment available in school shops.

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setup."** Chapter 12, **"Grinding Machines: Surfaces, Cylindrical, and Internal Grinding,"** pp. 411-449. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.
Johnson. **"General Industrial Machine Shop."** Section 10, **"Grinding and Grinding Machines,"** Unit 86, 87, 88, 89, 90, pp. 475-498. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, PP. 83-129.
Norton Company. **"Grinding, Abrasive and Grinding Wheels."**
Norton Company. **"Toolroom Grinding."**
Norton Company. **"Surface Grinding."**
Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.
Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

PERFORMANCE OBJECTIVE V-TECS 142

EVALUATION

Questions

1. Why is preventive maintenance so important in any shop facility?
2. List three probable failures caused by improper or inadequate lubrication?
3. List three common methods used to lubricate equipment.
4. Why is grease better than oil in certain applications?
5. List the steps to be followed when lubricating any machine.

Answers

1. Preventive maintenance is important because it provides the maintenance people a way to keep a close check on the condition of their equipment. A regular monthly inspection, cleaning, and lubrication of each machine is scheduled and carried out. The machine is closely checked for damage and wear while it is being serviced. Any possible problem may be spotted and repaired before it becomes a major breakdown. This system will save down time on equipment, thus increasing productivity, the most important thing in industry today.

2. a. Shafts may freeze to bearing surfaces or cause the bearing to distort due to heat caused by friction.
   b. Rapid wear will cause spindles and drive shafts to run untrue or wobble, causing excessive wear on bearings and sleeves.
   c. Corrosion (rust), the main enemy of all machinery will result if the protective layer of grease or oil is not maintained.

This short list is only a few of the many possible answers to this question. Lubrication is the primary protection of all moving, mated parts. Other acceptable answers include:

a. Prevent friction (heat, wear).
b. Reduce metal to metal contact, preventing wear.
c. Provide a metal separating wedge of lubricant, which dampens shock loads.
d. Dissipate heat.
e. Prevent rust and corrosion.
f. Barrier against contamination.

3. a. Manually: The man with the hand operated grease gun or hand oiler is the best, and most thorough method of lubricating any piece of equipment.
   b. Gravity or drip: Most commonly used on slowly operating equipment. An oil cup is filled and the lubricant drips onto the parts to be lubricated.
   c. Bath method: The part or parts to be lubricated are partially submerged in a bath of lubricant. As they operate, the lubricant is carried to all other parts of the system.

There are other methods suggested and these are not the only answers. Others listed are:

a. Splash
b. Pressure.

Evaluation Continued

4. Grease, being a thicker more sticky substance, will cling more effectively to the surfaces it is supposed to lubricate. Thus it will stay where it is placed. Oil will run off or be thrown off when the equipment is operated. Selection of the proper lubricant is very important for this reason alone.

5. A suggested procedures list.
    1. Make proper use of personal safety equipment.
    2. Follow established lockout routine before doing any work.
    3. Clean all oil and grease fittings prior to applying lubrication.
    4. Check machine for damage. Repair or replace broken/damaged fittings.
    5. Clean and inspect all working surfaces for damage or excessive wear.
    6. Check for worn or damaged drive belts. Repair or replace if required.
    7. Refer to manufacturer's manual for proper lubricants to be used and locations of lubrication points.
    8. Apply sufficient lubricant to each lubrication point and wipe clean before moving to next.
    9. Apply a light coat of oil to all exposed, bare metal surfaces.
    10. Check for spills and drips and general clean-up before moving to next machine.
    11. Remove lockout device and turn power back on according to established shop procedures.

DUTY: PERFORMING GRINDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 143

TASK: Change coolant in grinding machine.

CONDITIONS: A grinding machine, coolant, additive, coolant specifications and the following tools and equipment:

Coolant pail
Lock
Hand or power pump
Manufacturer's manual
Personal safety equipment
Putty knife or scraper
Screwdriver
Wrenches, open-end
Wrenches, socket.

STANDARD: When completed, coolant must contain additive in accordance with specifications to prevent rusting of workpiece or grinding machine.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Consult manufacturer's manual for type grinder.
2. Turn on main power source of grinder.
3. Place pail under coolant hose nozzle.
4. Pump coolant from reservoir until empty.
5. Flush coolant system. Check connections for leaks.
6. Turn off coolant pump.
7. Turn off/lock out main power source of grinder.
   NOTE: Test for "off" condition.
8. Clean coolant reservoir. Use scraper if necessary.
9. Prepare coolant according to specifications.
10. Refill coolant reservoir to specifications.
11. Unlock power.
12. Test coolant system for flow.

ENABLING OBJECTIVES

Use safety procedures when working on any electrically powered tool.
Use standard procedures for general maintenance of equipment.
Identify coolants and coolant additives.

PERFORMANCE OBJECTIVE V-TECS 143

LEARNING ACTIVITIES

1. Read handbook on electrical safety. Write a complete description of the proper procedures for electrical safety when working on any powered equipment.
2. Attend a lecture on electrical safety given by representative speaker from local power company.
3. Participate in class discussions of safety practices to be followed at all times.
4. Practice lockout procedures on various types of equipment.
5. Read manufacturer's manual concerning general maintenance of the equipment. Describe the standard procedures recommended for general care of the equipment. Read section concerning coolants and coolant additives for the equipment. Explain reason for selections.
6. Review textbook section on preventive maintenance procedures in Introduction to Machine Shop Practices, pp. 19-24.
7. Participate in class discussions on preventive maintenance procedures commonly followed in industrial plants.
8. Attend a lecture/demonstration given by a representative speaker from a local industrial maintenance shop or department.
9. Tour an industrial plant with the maintenance supervisor. Discuss why and how of maintenance procedures.
10. Study information sheet on Changing Coolant prepared by instructor describing a standard procedure to be followed when changing coolants in any machine.
11. Practice changing coolants in the equipment available in the school shops.

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 12, **"Grinding Machines: Surface, Cylindrical, and Internal Grinding,"** pp. 411-449. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Johnson. **"General Industrial Machine Shop."** Section 10, **"General Industrial and Grinding Machines,"** Units 86, 87, 88, 89, 90. pp. 475-498. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

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Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **Dimensions and Notes,"** pp. 42-63.

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

Handout - Appendix 6 - (Changing Coolant).

PERFORMANCE OBJECTIVE V-TECS 143

EVALUATION

Questions

1. Why is it important that coolants be changed regularly in grinding machines?
2. What would be the result if plain water was used as the coolant in a grinding machine?
3. What is "water soluble oil?"
4. What is the purpose of an anti-bacterial agent in the coolant?
5. List the procedures to be followed when changing coolant in any machine.

Answers

1. Coolants should be changed regularly because they can become contaminated with foreign materials, and/or bacteria. Proper coolant mixtures are usually white or light blue in color and contain only water, water-soluble oil, and an anti-bacterial agent. In use, the coolant will become mixed with residue from the material being cut, oil and other types of cutting fluids used when the coolant is not used, and bacterial growth may occur if tanks are not cleaned regularly causing unpleasant odors, possibility of infections and skin problems, etc.

2. Plain water used as a coolant would soon cause the machine to rust. All metal working machines depend on the coolant to perform several functions. It provides a way to carry heat away from the cutter, it carries the residue of the cut away from the cutter as well. The coolant provides a lubricant for the cutter so that it will cut freely and not bind. It provides a protective coating to the workpiece, cutter and machine parts to prevent corrosion when properly mixed. Water alone would only cool the cutter and carry the residue from the cut away. It would not lubricate the cutter in any way and might even cause binding. Any carbon steel material coming into contact with the water would rust quickly. Imagine, the work piece, cutters, table top, gears and operating system of the machine all rusted out the next day, if plain water was the only coolant used.

3. Water soluble oil is an oil based chemical designed to be mixed with water so that it might be used as a cutting coolant/lubricant.

4. Antibacterial agents are used in coolant tanks to prevent the growth of bacteria which may be harmful to the machine operator. They also prevent the offensive smell caused when some varieties of bacteria grow in coolants.

5. Refer to next page, or the information sheet on changing coolants.

Answers Continued

The standard procedures to be followed are listed below. These rules hold for any machine using coolants.

1. Turn on Power.
2. Using the pump in the machine, pump all coolant (all the pump will pick up) into a bucket, 55 gallon drum or into drain system. Check to see if all coolant has been removed from reservoir.
3. Flush coolant system with fresh water. Use a hose or add water with buckets until water comes out clear and clean.
4. TURN OFF ELECTRIC POWER, LOCK OUT, and TAG.
5. Clean reservoir tank. Scrape all residue from the tank and wipe clean if possible.
6. Check return systems. Clean inlets, check for leaks and broken or damaged hoses.
7. Refer to manufacturer's manual for the recommended coolant and coolant additives.
8. Mix proper amounts of coolant, additives and, if required, water.
9. Pour sufficient amount into reservoir to insure pump inlet is under surface.
10. Remove lock out and turn on power.
11. Using the system pump to provide circulation, pour remaining coolant mixture into reservoir and allow to cycle through the system.
12. Check for leaks or stoppage of flow through returns.
13. Clean floors of all spills.
14. Remove tag from power to complete.

Note: An additive to prevent bacterial growth is recommended as well as a disinfectant. This will prevent strong, unpleasant odors.

DUTY: PERFORMING GRINDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 144

TASK: Cut off material with grinding machines.

CONDITIONS: A metal workpiece, specifications and the following tools and equipment:

Face shield
Grinding machine with attached work holding device
Grinder operator's manual
Maintenance mechanic's tool box (hand tools)
Personal safety equipment.

STANDARD: When completed, the cut must be within ±1/64" of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Burghardt, et al. **Machine Tool Operation**, Part II, pp. 442-451.

PERFORMANCE GUIDE

1. Lay out cut on workpiece.
2. Select/mount/change cut off wheel if necessary. Check for cracks.
3. Change coolant if necessary.
4. Position/secure workpiece.
5. Place face shield over safety glasses.
6. Start machine (cut off wheel).
7. Turn on coolant if so equipped.
8. Cut material with grinder (cut off wheel). Start cut, back off, recheck for proper length. Then continue the cut.
9. Stop grinder (cut off wheel).
10. Shut off coolant.
11. Remove material. Check dimensions.
12. Remove face shield.

ENABLING OBJECTIVES

Use personal safety rules.
Use grinding and grinders safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for grinding wheels.
Read a blueprint.

PERFORMANCE OBJECTIVE V-TECS 144

LEARNING ACTIVITIES

1. Read textbook on Machine Shop Operations and Setup, pp. 411-449, on grinding procedures. Answer questions at end of chapter.
2. Study handbook on safety procedures to be used when mounting grinding wheels. Write a description of the proper procedure to be followed when mounting any grinding wheel.
3. Attend a lecture/demonstration on safety procedures to be followed when mounting any grinding wheel.
4. Practice mounting grinding wheels of various types on grinding machines.
5. Participate in a class discussion on safety procedures when using grinding machines.
6. Attend a lecture/demonstration on typical grinding procedures.
7. Tour a shop facility where a lot of grinding is performed. Observe techniques and procedures followed.
8. Attend a lecture/demonstration on cutoff grinders.
9. Participate in a classroom discussion and demonstration of cutoff grinder procedures.
10. Set up a cutoff wheel on a grinder designed for cutoff work.
11. Practice cutting off material with a cutoff grinder.
12. Cut off work to specified lengths with a cutoff grinder.

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 12, **"Grinding Machines: Surface, Cylindrical, and Internal Grinding,"** pp. 411-449. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Johnson. **"General Industrial Machine Shop."** Section 10, **"Grinding and Grinding Machines,"** Units 86, 87, 88, 89, 90, pp. 475-498. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

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Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. Describe a typical cutoff wheel.
2. List the safety procedures to be followed when using a cutoff wheel.
3. List some occasions when a cutoff wheel would be better than a power saw or hack saw.

Evaluation Continued

4. Why is it important that a coolant be used when cutting off with a cutoff wheel?
5. Can a cutoff grinding wheel be used for any other application in grinding? Explain your answer.

Answers

1. A cutoff wheel is a thin (usually not more than 1/16 in. wide) grinding wheel made of a strong woven fiber base impregnated with a cutting grit and a specially formulated bonding agent. The fiber base is what gives the wheel its shape and provides a base for the grit to attach. The bonding agent holds this together and prevents it from flying apart under use.

2. Procedures to be followed when using any grinder.

   a. Wear eye protection. (Safety glasses must always be worn, a safety face shield may also be worn but not in place of safety glasses).
   b. "Ring" test any grinding wheel before mounting it.
   c. Stand to one side when any grinder is first started. Should the wheel fly apart, you won't be the target for the pieces.
   d. Make sure all guards are in place and properly adjusted.
   e. Carefully secure workpiece to a magnetic chuck, vise, or other holding device.
   f. SLOWLY bring wheel into contact with the workpiece. Jamming the wheel into the work may cause the wheel to shatter. It will also destroy the workpiece.
   g. Turn on the coolant and begin grinding the workpiece.
   h. On completion of the grinding, move work well away from the grinding wheel. (Or, move the grinding wheel away from the work).
   i. Carefully remove the workpiece from the holding device and remove from the grinder to check dimensions or to finish.
   j. Turn off the wheel (unless further grinding is to be done). Turn off the coolant.
   k. Turn off the magnetic chuck and thoroughly clean all surfaces and catch pans.

3. 1. The most common is when the workpiece is too hard to be cut with a standard saw or hacksaw.
   2. Speed. A cutoff wheel works like a circular saw blade. Cuts very quickly.
   3. Small quantities of parts to be cut. (A factor of speed when lengthy setup procedures need to be made for few parts).
   4. When carefully set up, produces a finished end.

PERFORMANCE OBJECTIVE V-TECS 144

Answers Continued

4. Coolant provides several important benefits when using any grinding wheel.
    a. Carries heat away from the edge of the wheel and the workpiece. In cutoff, without a coolant, the workpiece could actually become hardened by the heat caused by the wheel.
    b. Carries the residue (chips) away from the cutter (wheel). Keeps the kerf clean so wheel won't bind and break.
    c. Reduces the possibility of fire caused by the sparks made by the wheel.

5. Yes. The cutoff wheel is still a grinding wheel. Any application where a narrow slot needs to be cut in a workpiece, or a groove made in a round piece. It saves time, and grinding wheels. Making a narrow edge on a standard grinding wheel is time consuming and difficult, especially when the slot or groove is less than 1/8" wide.

DUTY: PERFORMING GRINDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 145

TASK: Dress grinding wheel for internal/external grinding operations.

CONDITIONS: A grinding wheel, specifications, coolant as applicable and the following tools and equipment:

Grinder (pedestal, bench, cylindrical w/tool post/holding attachment)
Grinding machine manual
Grinding wheel dresser (diamond tool)
Personal safety equipment
6" scale
Wrenches, box end
Wrenches, open end.

STANDARD: When complete, the wheel must be dressed to specifications, free of glaze and loadings, valleys and ridges.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Inspect grinding wheel for damage. Ring test for cracks.
2. CAUTION: Damaged wheel must be replaced.
3. Place dressing tool in tool post or holding attachment. (Varies with type of grinder, pedestal, bench, cylindrical).
4. Set speed of grinder at regular grinding rate.
5. Adjust depth of cut to remove glaze and loading. Apply coolant/lubricant if necessary.
6. Stop wheel.
7. Check to specifications.
8. Start wheel.
9. Adjust depth of cut as necessary.
10. Stop wheel.
11. Check to specifications.

ENABLING OBJECTIVES

Use personal safety rules.
Use grinding and grinders' safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for grinding wheels.
Read a blueprint.
Interpret vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 145

LEARNING ACTIVITIES

1. Read textbook on Machine Shop Operations and Setups, pp. 411-449.
2. Study handbook on safety procedures to be used when mounting grinding wheels. Write a description of the proper procedure to be followed when mounting any grinding wheel.
3. Attend a lecture/demonstration on safety procedures to be followed when mounting any grinding wheel.
4. Practice mounting grinding wheels of various types on grinding machines.
5. Participate in a class discussion on safety procedures when using grinding machines.
6. Attend a lecture/demonstration on typical grinding procedures.
7. Tour a shop facility where mostly grinding is performed. Observe techniques and procedures followed.
8. Attend a lecture/demonstration on wheel dressing for inside and outside work.
9. Participate in a classroom discussion and demonstration of dressing procedures.
10. Set up diamond dresser and dress the wheel on a grinder.
11. Practice dressing grinding wheels with diamond dressers, star-wheel dressers and stick dressers under instructor supervision.
12. Dress grinding wheels on surface grinder, tool and cutter grinder, and all pedestal grinders in shop areas.

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 12, **"Grinding Machines: Surface, Cylindrical, and Internal Grinding,"** pp. 411-449. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

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Norton Company. **"Surface Grinding."**

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimension and Notes,"** pp. 42-63.

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58,

Rockwell Intl. **"Nomenclature Chart with Safety Suggestion."**

PERFORMANCE OBJECTIVE V-TECS 145

EVALUATION

Questions

1. Why dress a grinding wheel?
2. Describe a procedure for dressing the wheel on a tool (pedestal) grinder.
3. Describe 3 different types of wheel dresser.
4. What are some indications that the wheel needs to be dressed?
5. What does the term "loaded" mean when used to describe the condition of a grinding wheel?

Answers

1. Like any other cutting tool, grinding wheels get dull with use. They become glazed and/or loaded and need to be sharpened. This procedure is called dressing the wheel. A tool called a wheel dresser is used to restore the sharpness of the wheel, true up its cutting face, and to clean out imbedded metal particles from the cutting face.

2. See next page for a suggested procedure.

3. a. Star wheel dresser: A series of metal stars and washers mounted alternately on a shaft in a holder so they can spin freely. This is mashed against the face of the grinding wheel so as to remove or chip away the worn out parts of the wheel and prepare a fresh surface to be finished with a dressing stick.
   b. Dressing stick: A stick of material harder than the grinding wheel, usually carborundum, or norbide. Used after the star wheel dresser to finish the wheel face to a true grinding surface. Also used to shape grinding wheels for form grinding.
   c. Diamond dresser: A dressing stick with industrial diamonds impregnated into it. Alone it will clean, dress, and true a grinding wheel.

4. A wheel needs to be dressed when:
   a. It looks glazed (shiny).
   b. It becomes loaded: Particles of the material being ground become imbedded in the face of the wheel, preventing it from cutting.
   c. When it is first mounted on the machine.
   d. Before you start any job on a surface grinder.
   e. When the wheel needs to be trued up, usually indicated by excessive vibration when used.

5. A common condition of grinding wheels, when used heavily, is called loading. Loading can be described as particles of the material being ground becoming imbedded in the face of the wheel, preventing it from cutting.

A suggested procedure for dressing the wheel on a pedestal grinder.

NOTE: Always wear safety glasses.
NOTE: Always lock out power before working on any machine tool.

Answers Continued

1. Inspect the wheel/wheels for cracks, chunks broken out of wheel face, deep grooves gouged in the wheel face, etc. These are indications that the wheel has been mistreated and should be replaced.

2. If the wheels need to be replaced, proceed with wheel replacement procedures described elsewhere. While wheels are removed, clean all grit from wheel housings and chutes. Check spindles for excessive wear, straightness, and good threads for mounting nuts and flanges.

3. After new wheels are on and all guards are back in place, stand to one side and turn machine on.

NOTE: Remove lock out at this time but leave power tagged.

Let the machine run for several minutes to make sure that the new wheels are sound before continuing.

4. Use a star wheel dresser to true up the wheel and prepare the face for regular grinding. Change to a dressing stick to make the final preparation of the wheel face.

5. Turn off the machine. Relock out power.

6. Adjust the tool rests to the proper height and distance from the wheel face. Make sure all locking nuts and screws are tight before leaving.

7. Clean up any spills or mess. Vacuum up grit from dressing and remove lock out and tag to complete.

DUTY: PERFORMING GRINDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 146

TASK: Grind cylindrical surface.

CONDITIONS: A cylindrical workpiece, specifications for finished surface, coolant, lubricant and the following tools and equipment:

Cylindrical grinder
Dial indicator
Diamond wheel dresser
Drive dog
Grinding machine manual
Outside micrometer
Personal safety equipment.

STANDARD: When completed, the surface must be smooth and free of burn or chatter marks. Cylindrical surface must be within tolerance of specifications with T.I.R. (total inch runout) not to exceed .001".

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2011-2125.

Burghardt, et al. **Machine Tool Operation**, part II, pp. 478-480.

PERFORMANCE GUIDE

1. Identify material for grinding speeds and feed.
2. Select/mount wheel. Dress if necessary.
3. Attach drive dog to cylindrical workpiece. Check for tightness.
4. Lubricate centers.
5. Determine length of area to be ground.
6. Align workpiece in grinder.
7. Set stops for length.
8. Turn on power (main control).
9. Determine/set speed of wheel.
10. Determine/set speed of cylindrical workpiece.
11. Determine/set feed rate for longitudinal travel.
12. Check grinding wheel for cracks, loading, etc. Dress, replace, if necessary.
13. Start wheel (rotation).
14. Start cylindrical workpiece (rotation).
15. Position wheel to cylindrical workpiece.
16. Apply coolant as necessary.
17. Engage longitudinal travel feed.
18. Bring wheel to workpiece slowly.
19. Grind cylindrical workpiece.
20. Back wheel away from cylindrical workpiece.

Performance Guide Continued

21. Disengage longitudinal travel feed.
22. Turn off control for cylindrical workpiece (rotation).
23. Turn off wheel rotation control.
24. Turn off coolant.
25. Check measurement of workpiece.
26. Stop grinder.
27. Remove workpiece.
28. Remove drive dog from cylindrical workpiece.

ENABLING OBJECTIVES

Use personal safety rules.
Use grinding and grinders safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for grinding wheels.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setup on grinding procedures. Answer questions at end of chapter.
2. Study handbook on safety procedures to be used when mounting grinding wheels. Write a description of the proper procedure to be followed when mounting any grinding wheel.
3. Attend a lecture/demonstration on safety procedures to be followed when mounting any grinding wheel.
4. Practice mounting grinding wheels of various types on grinding machines.
5. Participate in a class discussion on safety procedures when using grinding machines.
6. Attend a lecture/demonstration on typical grinding procedures.
7. Tour a shop facility where a lot of grinding is performed. Observe techniques and procedures followed.
8. Attend a lecture/demonstration on cylindrical grinding, both internal and external.
9. Participate in a classroom discussion and demonstration of cylindrical grinder procedures.
10. Set up and practice cylindrical grinding both internal and external under instructor supervision.
11. Cylindrically grind various types of work to drawing specifications. Industry standards apply for finish, and dimensional tolerances.

PERFORMANCE OBJECTIVE V-TECS 146

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setup."** Chapter 12, **"Grinding Machines: Surface, Cylindrical, and Internal Grinding,"** pp. 411-449. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.
Johnson. **"General Industrial Machine Shop."** Section 10, **"Grinding and Grinding Machines,"** Units 68, 87, 88, 89, 90, pp. 475-498. Section 1, **"Introduction to Machine Shop Practices,"** Units 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.
Norton Company. **"Grinding, Abrasive and Grinding Wheels."**
Norton Company. **"Toolroom Grinding."**
Norton Company. **"Surface Grinding."**
Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**
Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

EVALUATION

Questions

1. Name three of the five basic types of cylindrical grinders.
2. List some reasons for cylindrical grinding.
3. What is plunge grinding?
4. Describe centerless grinding.
5. Why are some machined parts ground?

Answers

1. a. Center type: The standard cylindrical grinding machine. It has center points at the head stock and the tail stock between which the work is rotated while it is being ground.
   b. Centerless: This method uses a special type of machine which has no centers. Instead it uses three elements to perform the grinding operation: The grinding wheel, a regulating wheel, a counter rotating wheel used to rotate the workpiece, and a work-rest blade. The regulating wheel actually rotates the part to be ground.
   c. Chucking: Instead of mounting the workpiece between centers, it may be held by a chuck or collet.
   d. Toolpost: The tool post grinder is familiar to any lathe hand. It is a grinding machine which is attached to the tool rest on a lathe and used to grind work mounted in a lathe.
   e. Crankshaft and other special types: These machines are custom built for their specific task.
2. Cylindrical grinding is performed for a number of reasons. Some are:
   a. To produce highly polished, smooth, accurate surfaces. Example, the surfaces of sleeve bearings, and the surfaces of shafts passing through sleeve bearings.

Answers Continued

   b. To produce the very accurate dimensions on critical parts needed in today's technology.
   c. It is the only method by which some space age materials may be machined. Some tool steels can also be so hard that grinding is the only effective method for machining.

3. There are times when the workpiece is not moved across the face of the grinding wheel. This could be when grinding shoulders, or the part to be ground is shorter than the width of the wheel. This type of operation is called plunge grinding. Plunge grinding is the process of grinding a predetermined shape and/or diameter on workpiece by plunging the wheel into the surface of the workpiece and shaping it in one continuous grind.

4. Centerless grinding is, as its name implies, the process of cylindrically grinding without holding the workpiece between centers as is commonly done. It is primarily used in production to straighten workpieces or to produce large quantities of accurately sized materials. It is time saving because parts do not have to be set up and center drilled prior to grinding.

5. In any type of work there are only a few basic reasons for performing grinding operations on a workpiece:
   a. To produce highly polished, smooth, accurate surfaces.
   b. To produce the very accurate dimensions on critical parts needed in today's technology.
   c. It is the only method by which some space age materials may be machined. Some tool steels can also be so hard that grinding is the only effective method for machining.
   d. Grinding is a long accepted method for producing an effective cutting edge on any kind of cutting tool.

DUTY: PERFORMING GRINDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 147

TASK: Grind flat surface.

CONDITIONS: A ferrous metal workpiece, specifications, coolant and the following tools and equipment:

Dial indicator and base
Diamond wheel dresser
Grinding wheels
Holding blocks
Machinery's handbook
Outside micrometer
Personal safety equipment
Shim stock
Surface grinder with magnetic table or vise
Surface plate.

STANDARD: When completed, the surface(s) must be smooth and free of burn or chatter marks. Surface(s) must be true and flat within .005". The size must be within ±.005" of the specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 2028-2035.

PERFORMANCE GUIDE

1. Identify material of workpiece for selection of grinding wheel, speeds and feed.
2. Select/mount grinding wheel. Check for cracks and loading. Dress if necessary.
3. Secure workpiece to grinder table or vise. Use shims as necessary.
4. Set table stops.
5. Select/set feeds/speeds.
6. Start grinder wheel (rotation).
7. Position grinder wheel to workpiece.
8. Apply coolant as necessary.
9. Engage table feed or table rotation.
10. Bring workpiece to touch grinding wheel manually.
11. Grind flat surface(s).
12. Disengage wheel feed from workpiece and back wheel away.
13. Disengage table feed or table rotation.
14. Turn off coolant.
15. Stop wheel rotation.
16. Check size to specifications.
17. Remove workpiece from grinder.
18. Check surface trueness with surface plate and dial indicator.

PERFORMANCE GUIDE Continued

19. Turn off grinder.
20. Deburr workpiece if needed.

ENABLING OBJECTIVES

Use personal safety rules.
Use grinding and grinders' safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for grinding wheels.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setups, pp. 441-449 on grinding procedures. Answer questions at end of chapter.
2. Study handbook on safety procedures to be used when mounting grinding wheels. Write a description of the proper procedure to be followed when mounting any grinding wheel.
3. Attend a lecture/demonstration on safety procedures to be followed when mounting any grinding wheel.
4. Practice mounting grinding wheels of various types on grinding machines.
5. Participate in a class discussion on safety procedures when using grinding machines.
6. Attend a lecture/demonstration on typical grinding procedures.
7. Tour a shop facility where a lot of grinding is performed. Observe techniques and procedures followed.
8. Attend a lecture/demonstration on surface grinders.
9. Participate in a classroom discussion and demonstration of surface grinder procedures.
10. Set up and surface grind assorted workpieces to proper thickness as specified on sketch.

RESOURCES

Lasco, et al. **"Machine Shop Operations and Setup."** Chapter 12, **"Grinding Machines: Surface, Cylindrical, and Internal Grinding,"** pp. 411-449. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.
Johnson. **"General Industrial Machine Shop."** Section 10, **"Grinding and Grinding Machines,"** Units 86, 87, 88, 89, 90, pp. 475-498.
Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 12, 14, 15 16, 17. pp. 83-129.

Resources Continued

Norton Company. **"Grinding, Abrasive and Grinding Wheels."**
Norton Company. **"Toolroom Grinding."**
Norton Company. **"Surface Grinding."**
Olivo et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.
Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

EVALUATION

Questions

1. How is surface grinding different from cylindrical grinding?
2 What is a magnetic chuck?
3. Describe a procedure for grinding a thin piece of material to accurate thickness.
4. What is "Sparking Out?"
5. Why should a grinding wheel be dressed before taking a finish cut?

Answers

1. Surface grinding differs from cylindrical grinding in that the workpiece is securely held on a flat or other holding device. The workpiece does not move while it is being ground. In cylindrical grinding the work rotates against the counter-rotating grinding wheel. The grinding wheel passes back and forth over the workpiece, producing a smooth, flat surface.

2. A magnetic chuck is a device commonly used to hold workpiece while they are being surface ground. It is usually an electromagnetic device. When the power is turned off, the workpiece can easily be removed. Some magnetic chucks use a type of permanent magnet which can be turned on and off thus offering a safer system for use in the very wet conditions present in all grinding operations.

3. See next page for a suggested procedure.

4. Sparking out is a procedure performed at the end of a grinding operation. It is the repeated passing back and forth of the grinding wheel across the finished surface, without further infeed, until no further sparks are seen as the wheel moves over the work. This will produce a very smooth, highly polished, flat, accurate surface.

Answers Continued

5. A grinding wheel should always be dressed before taking a finished cut as a matter of course. During the heavier stock removal part of the job, small particles of the material being cut become imbedded in the surface of the wheel. These particles will cause scratches on the surface of the work and will prevent the wheel from doing its job by preventing the cutting action of the grit in the wheel. Dressing will remove these foreign particles and will expose fresh, sharp cutting edges on the grit so that the wheel will cut cleanly and smoothly for the very light finish cuts.

A procedure for grinding a thin piece of material.

1. Place the work on the chuck on its smoothest surface. Check for any high or low places and shim as required. Securely block the piece in before turning the chuck on.
2. Bring grinding wheel into contact with the work and grind first side until about 50 percent of its surface cleans up.
3. Remove from chuck. Clean chuck surface and replace work, this time on opposite face. Again check for high and low spots and shim accordingly. Block piece and turn on chuck.
4. Again grind until about 50 percent of surface cleans up.
5. Remove from chuck and clean chuck surface.
6. Check piece for thickness before continuing.
7. Place original surface on chuck, check again for high and low spots and shim accordingly, securely block work and turn on chuck.
8. Again grind surface until about 75 percent to 80 percent of its surface cleans up.
9. Again remove from chuck and clean surface, turn workpiece over again and block in place and turn on chuck.
10. Grind until side completely cleans up.
11. Remove, clean chuck and turn workpiece again and block securely and turn on chuck.
12. Grind until this side cleans up completely.
13. Remove from machine and check for thickness and uniformity, (same thickness all over). If the work is not to size, continue grinding a little on each side until the desired thickness is reached.

Answers Continued

14. Finally, remove the work from the chuck, thoroughly clean the chuck and the work surfaces of the machine. Dry all exposed, bare metal machine parts and apply a protective coating to complete.

If repeated turning of the workpiece is not performed as material is removed, it is quite likely that the work will curl due to unequal stress set up by the removal of too much material from one side.

DUTY: PERFORMING GRINDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 148

TASK: Sharpen drill bits.

CONDITIONS: A selection of drill bits needing sharpening, specifications, coolant and the following tools and equipment:

Allen wrench
Drill angle/grinding gage
Drill relief gage
Pedestal grinder
Personal safety equipment
Wheel dresser
Wrenches box/open end.

STANDARD: When completed, the drill bit(s) must have sharp uniform cutting edge, free of craters, nicks or burn marks. Heel must be lower than cutting lip. Cutting lips must be of equal length. Lip and relief angles must be within ± 15 minutes of drill grinding/relief gage(s) or specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 1827-1829.

PERFORMANCE GUIDE

1. Identify/determine angles of drill bit.
2. Inspect wheel for damage, uneven wear, eccentricity, glaze and loading.
3. Dress wheel if necessary.
4. Adjust tool rest, if necessary, to 1/8" from grinding wheel.
5. Start grinder (wheel rotation).
6. Sharpen drill bit. CAUTION: Do not allow localized heating. Either grind dry or use a steady flow of coolant.
7. Check drill bit to specifications.
8. Turn off grinder.
9. Test drill by drilling hole. Check chip formation and hole size.

ENABLING OBJECTIVES

Use personal safety rules.
Use grinding and grinders' safety rules.
Use drilling and drill tools.
Use measuring tools.
Use holding devices.
Use charts and table for grinding wheels.
Interpret vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 148

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setup, pp. 441-449 on grinding procedures. Answer questions at end of chapter.
2. Study handbook on safety procedures to be used when mounting grinding wheels. Write a description of the proper procedure to be followed when mounting any grinding wheel.
3. Attend a lecture/demonstration on safety procedures to be followed when mounting any grinding wheel.
4. Practice mounting grinding wheels of various types on grinding machines.
5. Participate in a class discussion on safety procedures when using grinding machines.
6. Attend a lecture/demonstration on typical grinding procedure.
7. Tour a shop facility where a lot of grinding is performed. Observe techniques and procedures followed.
8. Attend a lecture/demonstration on grinding drill bits in a drill bit grinder.
9. Participate in a classroom discussion and demonstration of grinding drill bits on a pedestal grinder.
10. Set up and grind drill bits on a drill bit grinder.
11. Grind drill bits on a pedestal grinder (off-hand grinding).
12. Cut off work to specified lengths with a cutoff grinder.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 10, **"Grinding and Grinding Machines,"** Units 86, 87 88 89, 90, pp. 475-498. Section 1 **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129. Section 6, **"Producing Cylindrical Holes,"** Unit 54 pp. 318-330.

Lasco, et al. **"Machine Shop and Operations and Setups."** Chapter 12, **"Grinding Machines: Surface, Cylindrical, and Internal Grinding,"** pp. 422-449. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49. Chapter 5, **"Drill Presses: Types: Setups, and Operations,"** pp. 106-150.

Norton Company. **"Grinding, Abrasive and Grinding Wheels."**

Norton Company. **"Toolroom Grinding."**

Norton Company. **"Surface Grinding."**

Ronan, William. **"Nomenclature Chart With Safety Suggestions."** **"Personal Safety."** **"Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. What is a drill-point gauge?
2. Why should one never burn the point of a drill bit with a grinder?
3. What will happen if there is no cutting clearance on the lip of the drill point?
4. Why is the angle on a drill bit different for different materials?
5. What is the difference between a chisel-point drill and a spiral-point drill?

Answers

1. A drill point gauge is a tool specifically designed to assist a mechanic when he is grinding bits. It consists of a standard 6" scale with a special scale attached which is ground to the correct 59 deg. angle for most drill points. The angular part of the gauge is also calibrated with a scale to provide a reference point for center. To use the gauge, one simply lays a drill along the scale with the point against the angular gauge. As the mechanic grinds the drill point he can check to make sure he is grinding the correct angle and by using the scale on the angular part, he can assure that each lip on the drill is the same length so that the point will remain "on center."

2. When any hardened metal is reheated it may become softer (annealed). If this happens with a cutting tool, then the cutting edge will not stay sharp. It is simply too soft. Any discoloration of the metal generally indicates that excessive heat has been generated which may have been enough for the material to lose its hardness.

3. Without cutting clearance, no tool will cut. It will rub, and if forced, will probably break.

4. Various materials have different properties when being cut. Adjusting the angle on the point of a drill bit will allow the material to be more easily cut. Correct cutting angles on drill points range from 150 deg. included for hard materials to 60. deg. included for soft materials such as aluminum or wood.

5. A chisel point is the standard point found on any drill bit. This point needs to have a center punch mark or center drilled hole to start in, otherwise it will not start accurately.
   A spiral point drill has a sharp point on the end. This allows the operator to start the drill accurately without having a center punched hole or spotted hole. These drills are especially useful in production work. Because of the accurate starting point the need for special drilling jigs is greatly reduced. They are also extensively used in CNC work.
   Another advantage of the spiral point drill is that they will produce a 50 percent more accurate diameter hole than a standard chisel point drill.

DUTY: PERFORMING GRINDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 149

TASK: Sharpen cutting tools bit.

CONDITIONS: A cutting tool bit(s) to be sharpened, specifications, coolant and the following tools and equipment:

Allen wrench
Bevel protractor
Contour gages
Grinder with accessories
Grinding wheel
Honing stone
Outside micrometer (1")
Personal safety equipment
Wheel dresser
Wrenches, box/open end.

STANDARD: When completed, tool bit must have sharp cutting edge free of craters, nicks or burn marks. Contour (shape) must conform to gage or specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook**, 21st ed., pp. 1806-1829.

PERFORMANCE GUIDE

1. Select/mount grinding wheel. Ring test for cracks. Inspect for damage, uneven wear, ridges, valleys, glaze, loading, and out-of-round. Report or replace if necessary.
2. Dress wheel if necessary.
3. Determine desired profile (shape) or tool bit.
4. Adjust tool rest if necessary.
5. Start grinder (wheel rotation).
6. Apply coolant if necessary.
7. Sharpen tool bit to gage or specifications.
8. Turn off grinder.
9. Turn off coolant if necessary.
10. Hone cutting edge.

ENABLING OBJECTIVES

Use personal safety rules.
Use grinding and grinders' safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for grinding wheels.
Read a blueprint.
Interpret vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 149

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setup, pp. 441-449 on grinding procedures. Answer questions at end of chapter.
2. Study handbook on safety procedures to be used when mounting grinding wheels. Write a description of the proper procedure to be followed when mounting any grinding wheel.
3. Attend a lecture/demonstration on safety procedures to be followed when mounting any grinding wheel.
4. Practice mounting grinding wheels of various types on grinding machines.
5. Participate in a class discussion on safety procedures when using grinding machines.
6. Attend a lecture/demonstration on typical grinding procedures.
7. Tour a shop facility where a lot of grinding is performed. Observe techniques and procedures followed.
8. Attend a lecture/demonstration on grinding any kind of cutting tool bit.
9. Participate in a classroom discussion and demonstration grinding various types of cutting tool bits.
10. Practice grinding various kinds of cutting tools.
11. Grind various cutting tools to print specifications and/or mechanics instructions.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 10, **"Grinding and Grinding Machines,"** Units 86, 87, 88, 89, 90, pp. 475-498. Section 1, **"Introduction to Machine Shop Practices,"** Units 6, pp. 38-47. Section 3 **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operation and Setup."** Chapter 12, **"Grinding Machines: Surface, Cylindrical, and Internal Grinding,"** pp. 411-449. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Norton Company. **"Grinding, Abrasive and Grinding Wheel."**

Norton Company. **"Toolroom Grinding."**

Norton Company. **"Surface Grinding."**

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet. pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. Explain why a cutting edge should be honed after grinding.
2. List the types of tool bits commonly sharpened by hand on a pedestal grinder.
3. What is a tool and cutter grinder?

Evaluation Continued

4. A surface grinder can be used to sharpen cutting tools. (True or False)
5. What are the advantages of having a tool grinding shop within a shop facility?

Answers

1. After grinding any tool or cutting edge, there is a microscopic wire edge left. Using a hone (a very fine stone) will remove this wire edge and also remove most of the rough edges left by the grinding wheel. The very smooth surface left will cut more easily and, because of the smoothness, will generate little heat so that the edge will last longer. A hone may also be used to generate the small radii on the point of some lathe tools so that very smooth finishes may be produced without hand work.
2. The pedestal grinder found in most shops is a very versatile grinder. It can be used to sharpen almost any kind of cutting tool. With the proper attachment it can sharpen drill bits, scissors, knives, lawn mower blades, planer and other flat types of cutting blades. Without fixtures a skilled user can sharpen drill bits, lathe cutting tools, knives, certain flat blades, axes, and wood chisels. Almost any tool which cuts with a sharp edge can be sharpened on this type of grinder. A skilled operator can also restore certain tools to proper condition.
3. A tool and cutter grinder is a special kind of grinding machine used in shops where a lot of cutter grinding is performed. This machine with its attachments can be used to sharpen any kind of cutting tool. In metal working shops, this machine is used to restore and sharpen metal cutting milling cutters, end mills, from milling cutters. It can be used to regrind dead centers, and center points. Any small cylindrical grinding job can be performed using this machine. They are also used in wood working shops for saw blades, lathe tools, shaper tools, router bits, drill bits etc. There is little that cannot be sharpened in a shop with this kind of grinder.
4. True
5. The advantages of having a grinding shop within a manufacturing facility should be obvious. With the rising costs of cutting tools and materials most companies cannot go out and keep buying tools and cutters to be thrown away when they become dull and/or broken. A tool and cutter grinding facility provides a service that saves the company a lot of money by resharpening tools and cutters which would have to be replaced. Cutters can also be restored after being broken as well. With such a facility available, a company would not have to wait for special cutters to be sent in from outside. They would simply have them fabricated in their own facility. Of course, there are throw away tools, cutters, and inserted bit cutters, but a grinding facility generally pays for itself in tool replacement savings, quick turn around on special cutters, and reducing down time caused by dull and/or broken cutters.

DUTY: PERFORMING GRINDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 150

TASK: Sharpen hand tools, such as center punches/chisels.

CONDITIONS: Hand tool(s) to be sharpened, specifications and the following tools and equipment:

Angle gages
Bevel protractor
Grinding wheels
Honing stone
Pedestal grinder
Personal safety equipment
6" scale
Water or coolant
Wheel dresser.

STANDARD: When completed, center punch or chisel profile must have uniform shapes and angles within tolerance of gage or specifications. Surfaces must be free of ridges, craters, nicks, burn marks or mushrooming.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Select/mount grinding wheel. Ring test for cracks.
   Inspect for damage, uneven wear, valleys, glaze, loading and out-of-round.
2. Dress wheel if necessary.
3. Select tool to be ground.
4. Determine profile (shape or angle) of tool to be sharpened.
5. Adjust tool rest if necessary.
6. Start grinder (wheel rotation).
7. Sharpen hand tool to specifications.
8. Turn off grinder.
9. Hone cutting edge.

ENABLING OBJECTIVES

Use personal safety rules.
Use grinding and grinders' safety rules.
Use measuring tools.
Use layout tools and techniques.
Use hand tools.
Use holding devices.
Use charts and tables for grinding wheels.
Read a blueprint.
Interpret vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 150

LEARNING ACTIVITIES

1. Read textbook on Machine Shop Operations and Setup, pp. 441-449 on grinding procedures. Answer questions at end of chapter.
2. Study handbook on safety procedures to be used when mounting grinding wheels. Write a description of the proper procedure to be followed when mounting any grinding wheel.
3. Attend a lecture/demonstration on safety procedures to be followed when mounting any grinding wheel.
4. Practice mounting grinding wheels of various types on grinding machines.
5. Participate in a class discussion on safety procedures when using grinding machines.
6. Attend a lecture/demonstration on typical grinding procedures.
7. Tour a shop facility where grinding is performed. Observe techniques and procedures followed.
8. Attend a lecture/demonstration on reshaping and restoring broken tools.
9. Participate in a classroom discussion and demonstration of reshaping and restoring broken or dull tools.
10. Practice sharpening and reshaping/restoring chisels, screw drivers, punches and center punches, nail sets, and other frequently mistreated shop tools.
11. Restore and sharpen chisels. Restore screw driver blades. Regrind punch and center punch points.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 10, **"Grinding and Grinding Machines,"** Units 86, 87, 88, 89, 90, pp. 475-498. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 12, **"Grinding Machines: Surface, Cylindrical, and Internal Grinding,"** pp. 411-449. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Norton Company. **"Grinding, Abrasive and Grinding Wheels."**

Norton Company. **"Toolroom Grinding."**

Norton Company. **"Surface Grinding."**

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions." "Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

PERFORMANCE OBJECTIVE V-TECS 150

EVALUATION

Questions

1. What is the correct angle for the point on a center punch? A prick punch?
2. Describe a series of steps for restoring a chipped chisel edge.
3. What is the correct shape (angle) of a screw driver blade?
4. What is the best grinder to use for general restoration work?
5. What will happen to any of these tools if they get too hot and burn during the rework?

Answers

1. A center punch should be ground to an included angle of 90 degrees. A prick punch should be ground to an included angle of 30 degrees.

2. A suggested method for restoring a nicked or chipped flat blade such as a chisel, hand plane iron, or power plane cutter blade.
   a. If working by hand on a bench or pedestal grinder, set the tool rest square with the face of the wheel, place the tool flat on the tool rest and grind the front or cutting edge until the chip or nick is removed, leaving a smooth flat edge. Remember, this edge must be kept square with the sides if the tool is a chisel or hand plane iron. Planer blades should have the cutting edge parallel to the back edge. Check for squareness with a solid square, check for parallel with mikes.
   If working on a surface grinder, make sure blade is perpendicular to the wheel. Use only fixtures designed for chisels and plane irons. Make sure setup is square.

   b. Adjust the tool rest on the pedestal/bench grinder to the proper cutting angle for the tool being ground. Carefully grind the proper cutting angle on the tool, making sure to maintain the squareness of the cutting edge. Bring the cutting edge to a razor sharpness. Recheck for square and regrind until square, if necessary.
   On a surface grinder, set fixture to proper cutting angle and grind tool to razor sharpness.

   c. Carefully remove tool from fixture.

   d. Using a wet stone, carefully hone the cutting edge until the wire edge, raised by the grinding wheel, is removed. On certain tools, you will continue to hone the cutting edge until it is smooth and free from any roughness left by the grinding wheel.

   e. Clean the tool with a soft rag and lightly oil it. For protection, cover the edge with something, or place tool in a container designed to protect the edge until used to complete.

Evaluation Continued

3. There is NO correct angle for the screw driver blade. The flat sides of a screw driver blade are parallel at the edge. Any angle at all will cause the blade to spread the slot and slip.

4. The best grinder to use for most restoration work is the bench/pedestal grinder. A skillful operator can do almost any type of work with this machine.

5. Excessive heat caused by the friction from the grinding wheel will destroy the hardness/temper of the cutting edge you are trying to restore. Keep the tool cool by dousing in water often while grinding (or flood with water while actually grinding).

DUTY: PERFORMING GRINDING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 151

TASK: Deburr with hand grinder.

CONDITIONS: A metal workpiece, specifications and the following tools and equipment:

Allen wrench
Bench vise
Chuck key
Extension cords (electrical or air)
Hand grinder with deburring elements (stones, discs, deburring tools, etc.)
Isolation curtain or shield
Personal safety equipment
Respirator.

STANDARD: When completed, the surface(s) must be smooth with no sharp corners and free of burrs in accordance with specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Determine area to be deburred.
2. Secure workpiece in vise.
3. Mount deburring element(s).
4. Attach power source.
5. Isolate grinding area with curtain or shield.
6. Start grinder.
7. Deburr workpiece to specifications.
8. Turn off grinder.
9. Check material for burrs.
10. Detach power source.
11. Put away workpiece.

ENABLING OBJECTIVES

Use personal safety rules.
Use grinding and grinder safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding device.
Use charts and tables for grinding wheels.
Read a blueprint.
Interpret vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 151

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setup on grinding procedures. Answer questions at end of chapter.
2. Study handbook on safety procedures to be used when mounting grinding wheels. Write a description of the proper procedure to be followed when mounting any grinding wheel.
3. Attend a lecture/demonstration on safety procedures to be followed when mounting any grinding wheel.
4. Practice mounting grinding wheels of various types of grinding machines.
5. Participate in a class discussion on safety procedures when using grinding machines.
6. Attend a lecture/demonstration on typical grinding procedures.
7. Tour a shop facility where a lot of grinding is performed. Observe techniques and procedures followed.
8. Attend a lecture/demonstration on hand held grinders.
9. Participate in a classroom discussion and demonstration of hand held grinders. (Handi-grinders, disc grinders).
10. Practice using a hand grinder to grind burrs and sharp edges from various workpieces. Practice grinding welds smooth and flat. Practice dressing off rough material.
11. Grind burrs and sharp edges off a work piece. Finish all edges and surfaces to print specifications.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 10, **"Grinding and Grinding Machines,"** Units 86, 87, 88, 89, 90. pp. 475-498. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 12, **"Grinding Machines: Surface, Cylindrical, and Internal Grinding,"** pp. 411-449. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Norton Company. **"Grinding, Abrasive and Grinding Wheels."**

Norton Company. **"Toolroom Grinding."**

Norton Company. **"Surface Grinding."**

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

PERFORMANCE OBJECTIVE V-TECS 151

EVALUATION

Questions

1. Why is the ability to properly use a hand grinder important?
2. Explain why burrs and sharp edges should be removed from any work piece.
3. What are some of the attachments that can be used with various hand held grinders?
4. What unique finishing work can be accomplished using hand grinders?
5. List the safety rules for hand held grinders.

Answers

1. The ability to use a hand grinder is important because it is a quick and efficient way to remove burrs and sharp edges from a work piece. It is a quick way to perform certain operations which cannot be done any other way. A skillful operator can produce finished work using hand held grinders.

2. Burrs and sharp edges should never be left on any work piece for a number of reasons:
   a. The next person (or yourself) to hand the piece may be injured or badly cut by a sharp or rough edge left on the piece.
   b. If all sharp or rough edges are not removed, the piece may not fit into fixtures designed to hold it for the next operation.
   c. If all sharp or rough edges are not removed, the piece may not fit or work smoothly with the part it is supposed to mate with.
   d. As a matter of pride, all sharp, rough edges should be removed. No one should turn out sloppy, half finished work. Deburring is part of the finishing work on any job.

3. The list of attachments for various hand grinders is very long. Some of the more common attachments are:
   a. Mounted grinding wheels. (Wheels already attached to a mounting shaft for attachment to a hand grinder).
   b. Disc grinding devices. Back up plates, guards.
   c. Rotary cutting tools called burrs and rotary rasps.
   d. Mounted wire brushes for cleaning and polishing.
   e. Fiber polishing wheels.

   The list is endless. The instructor should make his own list.

4. Certain types of hand grinders can be used for die work and engraving. This type of work is done by highly skilled users of hand held grinding tools. This work is typically seen in the form of the change in your pocket, the engraving on a bracelet, a sign, or the lettering that is part of almost any cast object you purchase today.

5. A list of safety rules for hand held grinders might include the following items.

   a. Wear your safety glasses/goggles. (A face shield may or may not be required depending on the type of grinding being done).

Answers Continued

b. Keep all power cords in good repair. Broken plugs, cuts or breaks in the outer jacket are dangerous. If air hoses are used the same rules apply. Make sure there is no dry rot in the hose, and that the connectors are tight.

c. Be sure you attach your cord (or hose) to the proper source. Oxygen, air, gas, and water lines tend to look alike. Electric sources should also be carefully checked before plugging in and starting.

d. Check the grinding wheel carefully. Any sign of damage is an indication of misuse and the wheel should be removed and replaced with a new one. (Always ring test a new wheel before mounting).

e. Make sure that all guards are in place on the grinder. If no guard is present, and you feel there should be one, point it out to your safety officer and supervisor. Set up a guard or shield/screen if the grinding you are doing is throwing a lot of sparks (hot chips). Use a guard around the work piece in any case.

This is a short list of the major basics. If the instructor desires a longer list he may adopt one of his own.

PERFORMING MILLING OPERATIONS

DUTY: PERFORMING MILLING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 152

TASK: Bore out bushing.

CONDITIONS: A workpiece containing frozen bushing, specifications and the following tools and equipment:

Boring head/bar/tool
Machinery's handbook
Mechanic's tool box (hand tools)
Micrometer (outside)
Milling machine
Personal safety equipment
Table clamps
Table vise
Telescoping gage
Vernier caliper (inside/outside).

STANDARD: When completed, bushing bore must have smooth finish and T.I.R. (total inch runout) of .0005". Size of bushing bore must be within ±.005" of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Identify workpiece material for selection of cutting speeds and feed.
2. Identify size of finished bore in bushing.
3. Select/install boring head/bar/tool.
4. Secure workpiece to table of milling machine.
5. Align cutting tool to hole.
6. Secure table locks.
7. Start machine (main control).
8. Set spindle speed control to predetermined spindle speed.
9. Set feed control to predetermined rate of feed.
10. Engage spindle speed control.
11. Start boring cut manually.
12. Engage feed control.
13. Bore out bushing. Make rough cuts as necessary.
14. Disengage feed control.
15. Retract boring tool.
16. Disengage spindle speed control.
17. Check dimensions of bore with telescoping gage and outside micrometer.
18. Remove workpiece.
19. Turn off milling machine.
20. Remove boring head/bar/tool.

PERFORMANCE OBJECTIVE V-TECS 152

ENABLING OBJECTIVES

Use personal safety rules.
Use grinding and grinders safety rules.
Use measuring tools.
Use layout tools and techniques.
Use hold devices.
Use charts and tables for cutting speeds, feeds, and cutter selection.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setups pp. 307-360 on milling machine operations. Write answers to questions at end of chapter.
2. Participate in classroom discussion on milling operations. (Reference material- student handout and written homework)
3. Attend a lecture presentation on drilling on a milling machine. Participate in question and answer period at end of presentation.
4. Observe presentation by instructor of proper procedures for setting up, boring, and deburring holes.
5. Observe presentation by instructor or other demonstrator showing proper methods for boring very accurate sized holes.
6. Practice set up, and boring holes using a milling machine under instructor supervision.
7. Set up, and bore holes to size specified. Have instructor inspect work for size and location accuracy.
8. Practice boring very accurate holes (size and location) using techniques demonstrated.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 9, **"Machining Metal with Milling Machines,"** Units 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, pp. 415-474. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 9, **"Milling Machines: Types, Construction, Accessories and Attachments,"** pp. 279-306. Chapter 10, **"Milling Machines: Milling Cutter, Setups, and Operations,"** pp. 307-360. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring pamphlet, pp. 13-15, 17-23, 56-58.

PERFORMANCE OBJECTIVE V-TECS 152

EVALUATION

Questions

1. What is a bushing? Why do they need to be bored out and replaced?
2. Describe the difference between a boring tool holder and a drill chuck.
3. Describe a suggested method of set up for boring on a milling machine.
4. Describe boring, as it pertains to machine shop work.
5. List some very accurate ways for measuring bored diameters.

Answers

1. A bushing is a sleeve bearing (usually made of brass, bronze, or similar material) which is press fitted into a workpiece to provide a very accurate, straight hole for a shaft to operate through. When a bushing becomes worn, it gets slightly larger allowing the shaft to wiggle or wobble and produce vibration which in turn may create other problems in the system. When this condition becomes evident the only cure is to bore the bushing out and replace it.

2. A boring tool holder is a device which not only holds the tool the same as any drill chuck, it also provides for lateral adjustment of the tool (or eccentric adjustment) thus allowing the cutting tool to cut larger diameters.

3. A suggested method of set up for boring on a milling machine.
   a. Clamp the workpiece to the table or in a vise or other holding device.
   b. Using an indicator or other accurate centering device, locate the centerline of the spindle on the centering of the bushing to be bored.
   c. Mount a boring head in the machine and adjust the tool to just skim the ID of the bushing to be bored. Make a trial Pass through the workpiece and measure the bore with an inside mike, telescoping gage/micrometer combination, or verniers.
   d. Adjust the tool to take a reasonable cut and engage the machine feed to cut through the piece.
   e. Continue until the old bushing is cut completely out. Carefully bore the hole until all the bushing is gone and the hole is the size required for a press fit with the new bushing.
   f. Remove the workpiece from the machine and clean off oil and grease, deburr and press new bushing into place using an arbor press to complete.

4. Boring is the process of enlarging an existing hole (inside diameter) to an extremely accurate diameter and straight, smooth finish using a rotating single point cutting tool. The only difference between boring on a mill and boring on a lathe is that on a lathe the work rotates.

Evaluation Continued

5. There are several accurate methods for measuring bored holes accurately, (any hole for that matter).
    a. Telescoping gage/micrometer: This method requires the use of two different tools. The first, the telescoping gage, is a device which can be fitted into the hole, adjusted for a proper fit and then measured with a micrometer.
    b. Gage pin: A good method for checking bored holes uses gage pins. These are precision ground, hardened pins which are try fitted into the hole to check actual working size. These pins come in sets and are ground in .001 steps, thus providing an excellent, easy method for checking actual sizes of holes and slots.
    c. Inside mikes, vernier calipers: These are the old stand bys. These are standard precision measuring tools which are used to get the measurement from the inside to the outside and then checked using the familiar micrometer.
    d. Bore gage: This is a highly accurate measuring tool which is first set to the size required. Then it is inserted into the hole and a reading (taken from an indicator face) will indicate the exact size of the hole plus or minus.

DUTY: PERFORMING MILLING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 153

TASK: Cut external keyway.

CONDITIONS: A metal workpiece, specifications of keyway, keystock, coolant and the following tools and equipment:

Dial indicator to set work piece
End milling cutters
Machinery's handbook
Maintenance mechanic's tool box (hand tools)
Milling machine
Personal safety equipment
Scale - 6"
Work holding device.

STANDARD: When completed, the keyway must have smooth finish and snug fit with mating keystock. Length of keyway must be within ±0.0005" and -0.000". The center line position must be within ±0.005" from end of workpiece.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Determine size of keyway.
2. Identify material for selection of cutting speeds/feed.
3. Lay out keyway.
4. Secure workpiece in holding device.
5. Select, mount, and secure cutter endmill.
6. Position workpiece to cutter.
7. Secure table locks.
8. Select/set spindle speed control.
9. Select/set table feed control.
10. Engage spindle speed.
11. Start cut manually. Check alignment.
12. Engage table feed.
13. Apply coolant.
14. Cut keyway.
15. Disengage table feed.
16. Disengage spindle speed.
17. Stop coolant flow.
18. Shut off milling machine.
19. Check keyway size and fit with mating keystock.
20. Remove milling cutter.
21. Remove workpiece.
22. Deburr keyway.

PERFORMANCE OBJECTIVE V-TECS 153

ENABLING OBJECTIVES

Use personal safety rules.
Use milling machines safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for cutting speeds, feeds, and cutter selection.
Use milling cutters.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setups, pp. 307-360 on milling on machine operations. Write answers to questions at end of chapter.
2. Participate in classroom discussion on milling operations. (Reference material - student handout and written homework).
3. Attend a lecture presentation on end mills and wheel cutters. Participate in question and answer period at end of presentation.
4. Observe presentation by instructor of proper procedures for setting up and milling slots and grooves using end mills and wheel cutters.
5. Practice set up and milling slots and/or grooves using end mills and wheel cutters on a milling machine under instructor supervision.
6. Set up and mill slots to size specified. Have instructor inspect work for size and location accuracy.
7. Practice milling very accurate slots and grooves (size and location) using techniques demonstrated.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 9, **"Machine Metal with Milling Machines,"** Units 75, 76, 77, 78, 80, 81, 82, 83, 84, 85, pp. 415-474. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 9, **"Milling Machines: Types, Construction, Accessories and Attachments,"** pp. 279-306. Chapter 10, **"Milling Machines: Milling Cutters, Setups, and Operations,"** pp. 307-360. Chapter 2 **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions." "Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

PERFORMANCE OBJECTIVE V-TECS 153

EVALUATION

Questions

1. What is a woodruff key slot cutter?
2. What is the advantage/disadvantage of using an end mill for cutting key slots?
3. What would be the result of too wide a key slot? What would be the result of too deep a key slot?
4. Why are key slots necessary?
5. Why is extreme accuracy in location of slot so important?

Answers

1. A woodruff key slot cutter is a special type of milling cutter specifically designed for cutting key slots. It is precision ground to the exact sizes required for standard keys.

2. Some advantages in using an end mill for cutting key slot:
   a. You will be working on top of the workpiece where you can see what you are doing. This is not always true, but still will be the case more often than not.
   b. You can generally cut deeper than with any type of wheel cutter (woodruff or standard) and can adjust the width of the slot cut to provide good snug fits for nonstandard sized keys.

3. Key slots which are cut too wide will allow the key to move sideways in the slot. This will cause the slot to become even larger and may permit the gear or other object keyed to the shaft to slip out of alignment or to shear off the key if permitted to continue.
   Key slots which are cut too deep will have the same general result, allowing slippage. In addition to the similar problems with a too wide slot, too deep a slot may allow the object keyed to the shaft to actually spin on the shaft possibly ruining the shaft, and the item attached.

4. The primary purpose for the key is to prevent rotation on the shaft. Properly sized and designed, a key/key slot arrangement is by far the best way to prevent a pulley or gear from turning on the shaft it is mounted on. This is most important when used with timing gears.

5. If care is not taken to accurately locate the key slot on the shaft it is quite likely that the slot will not line up with the mating slot in the gear or pulley. Internal key slots are cut with a tool and fixture which places the slot exactly on the centerline of the hole. Any misalignment of the matching slot will prevent the key from fitting snugly. If you make the key a little smaller to compensate for this misalignment you will introduce the too wide a slot problems.

DUTY: PERFORMING MILLING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 154

TASK: Cut internal keyslot using slotting attachments.

CONDITIONS: A metal workpiece with hole, specifications of slot, keystock, coolant and the following tools and equipment:

Machinery's handbook
Maintenance mechanic's tool box (hand tools)
Personal safety equipment
Scale - 6"
Slotting attachment
Slotting cutters
Vertical milling machine w/accessories
Work holding device.

STANDARD: When completed, the keyslot must have smooth finish and snug fit with mating keystock. Length of keyslot must be within ±0.010" and depth within +0.005" and -0.000". The center line position must be within ±0.005" from end of workpiece.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Burghardt, et al. **Machine Tool Operation.** Part II, pp. 147-148.

PERFORMANCE GUIDE

1. Identify material or selection of cutting speeds/feed.
2. Secure workpiece to table.
3. Position slotting attachment over table.
4. Select/mount cutting tool to spindle.
5. Select/adjust stroke length.
6. Align cutter to workpiece.
7. Select/set speed.
8. Cut slot to specifications. Check fit with mating keystock.
9. Remove slotting attachment/cutting tool.

ENABLING OBJECTIVES

Use personal safety rules.
Use milling machines safety rules.
Use measuring tools.
Use layout tools and techniques.
Use special cutting techniques.
Use charts and tables for cutting speeds, feeds, and cutter selection.
Read a blueprint.
Interpret vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 154

LEARNING ACTIVITIES

1. Read textbok Machine Shop Operations and Setups, pp. 307-360 on milling machine operations. Write answers to questions at end of chapter.
2. Participate in classroom discussion on milling operations. (Reference material - student handout and written homework)
3. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
4. Observe presentation by instructor of proper procedures for setting up and using the slotting attachment.
5. Practice slotting holes using a milling machine under instructor supervision.
6. Set up slotter attachment and cut slots for various specified key sizes. Have instructor inspect work for size and location accuracy.
7. Practice using the slotting attachment using techniques demonstrated.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 9, **"Machining Metal with Milling Machines,"** Units 75, 76, 77, 78, 79, 80 81, 82, 83, 84, 85, pp. 415-474. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 9, **"Milling Machines: Types, Construction, Accessories and Attachments."** pp. 279-306. Chapter 10, **"Milling Machines: Milling Cutters, Setups, and Operations,"** pp. 307-360. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions." " Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. Describe the cutting action of the slotting head.
2. Describe another acceptable method for cutting an internal key slot if the slotting head is not available.
3. List 3 different machines which can be used to cut key slots.
4. What would be the result of too wide a key slot?
5. List some other uses for a slotting head besides cutting key slots.

Answers

1. The cutting action of the slotting head is the same as the action of a shaper or a slotter. (shapers and slotters are two special machines designed to cut metal by the method described here). A slotting attachment is a device which changes the rotary action of the spindle of the machine to a reciprocating action. (reciprocating being an up and down or back and forth motion) The cutting tool is mounted in a holder attached to the slotting head attachment. The tool is brought into contact with the work and pushed across the surface, slicing off that portion of the material contacted by the tool. The tool then is returned to its starting point by the return stroke. The work is then moved slightly and the tool again is pushed across the work removing material again under the tool. This process is contained until the proper depth is reached.

2. a. There are other ways of cutting slots internally. The easiest is to use a hand tool called a broach. This is the most common, quick way to cut a key slot.
   b. Another method would be to use a shaper (a machine designed to cut with a reciprocating action of the cutting head). The set up would be the same as with the slotting head except that the cutting would be performed horizontally instead of vertically.
   c. A slotter (a machine specifically designed to cut slots) can also be used.

3. Some machines which can be used to cut internal key slots are:
   1. Milling machine/w slotter attachment
   2. A slotter (a machine designed to cut with a reciprocating action)
   3. A shaper (another machine designed to cut with a reciprocating action)
   4. A planner (a machine which cuts with reciprocating action). However it is the workpiece which is moved while the tool is held stationary.

4. A key slot too wide in a part mounted on another part with a key, would be able to move slightly against the key thus causing the key or the slot in the part to wear causing even more movement, etc. The result would be loss of accuracy, if the parts are part of a mechanical timing system, possible destruction of the mating parts if the key is sheared.

5. Once a slotting head is mounted there are many useful tasks which can be performed. Some of the other tasks might be:
   a. Cutting square holes or cut outs.
   b. Cutting "D" holes for mounting special parts.
   c. Cutting splines.

DUTY: PERFORMING MILLING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 155

TASK: Drill holes with milling machine.

CONDITIONS: A metal workpiece, specification for hole(s), coolant and the following tools and equipment:

Chuck key
Dial indicator
Drill bits
Machinery's handbook
Milling machine
Outside micrometer
Personal safety equipment
Small hole gage
Table clamps.

STANDARD: When completed, hole(s) must have smooth finish and T.I.R. (total inch runout of 0.003". Hole(s) must be to size and located within tolerance of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practices**, vol. 2, pp. 153-160.

PERFORMANCE GUIDE

1. Identify material for selection of cutting speeds and feed.
2. Determine size and type of hole (through or blind) from specifications.
3. Clamp workpiece to table.
4. Chuck center drill bit/pilot drill.
5. Turn on machine.
6. Position workpiece to drill bit.
7. Secure table locks.
8. Select/set spindle speed.
9. Set feed contol at selected rate of feed.
10. Engage spindle.
11. Start pilot hole manually. Check for location.
12. Turn on coolant.
13. Engage feed.
14. Drill pilot hole.
15. Disengage feed.
16. Disengage spindle.
17. Turn off coolant.
18. Select/mount drill. Step drill and reset speed/feed as necessary.
19. Turn on spindle/feed.
20. Turn on coolant.
21. Drill hole(s).
22. Disengage feed.
23. Disengage spindle.
24. Stop coolant flow.

Performance Guide Continued

25. Check hole size.
26. Remove drill bit.
27. Repeat steps #18 through #26 as necessary - NOTE: Use mill graduated dials as appropriate.
28. Remove workpiece.

ENABLING OBJECTIVES

Use personal safety rules.
Use milling machines safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for speeds and feeds.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setups on milling machining and milling machine operations. Write answers to questions at end of chapter.
2. Participate in classroom discussion on milling machine operations. (Reference material - student handout and written homework)
3. Attend a lecture presentation on drilling on a milling machine. Participate in question and answer period at end of presentation.
4. Observe presentation by instructor of proper procedures for setting up, drilling, and deburring drilled holes.
5. Demonstrate methods for drilling very accurate sized holes.
6. Practice lay out, set up, locating, and drilling of holes using a milling machine under instructor supervision.
7. Lay out, set up, locate, and drill holes to size specified. Have instructor inspect work for size and location accuracy.
8. Practice drilling very accurate holes (size and location) using techniques demonstrated.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 9, **"Machining Metal with Milling Machines,"** Units 75, 76, 77, 78, 78, 79, 80, 81, 82, 83, 84, 85, pp. 415-474. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 9, **"Milling Machines: Types, Construction, Accessories and Attachments,"** pp. 279-306. Chapter 10, **"Milling Machines: Milling Cutter, Setups, and**

Resources Continued

Operations," pp. 307-360. Chapter 2, **"Measuring Tools: Semi-Precision,"** pp. 9-49.
Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**
Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. Why should all hole locations be center punched before drilling? List at least two.
2. A tool called a ____________ is used to accurately locate the edges and sides of a workpiece. Why is this setting so important?
3. What is a center drill? Why should it be used before drilling a hole in a workpiece.
4. What is the probable cause of a drill bit cutting oversize?
5. Why is a properly ground drill bit important when drilling plastics or brass?
6. Why is it a good idea to drill a pilot hole before drilling a hole to final size?

Answers

1. a. Provides a place for the point on a drill bit to start. Without it the point of the drill bit might "walk" away from the proper location.
   b. Clearly marks the spot where a drilled hole is to be located even if layout dye is wiped off.
   c. Provides an indentation for the point on a divider for scribing circles and other locating points on lay out work.

2. Edge finder or wiggler. It is important that the reference points be accurately located before any work is done. These tools provide the mechanic an accurate way of locating the centerline of the spindle directly over the reference points on the workpiece, (typically an end and one side). Once the machine is set at these reference points and the hand wheel dials or digital read-outs are set to zero, it is very easy to accurately locate locations on the surface by using these measuring devices to read the locations. (These measuring devices are built into the machine and once set provide a very accurate way to measure actual locations from reference points once they are set).

Evaluation Continued

3. The center drill/countersink is a special drill designed to start a drill in its proper location. Once the spindle is centered over the proper location, the first thing the mechanic should do is spot the hole location with a center drill and check to see if it is correct. Once satisfied the center drill can be used to provide an accurately located starting hole for the drill to follow.

4. The most probable cause of a drill cutting oversized is that the point is ground off center. This commonly happens when drill bits are off-hand ground by the mechanic. It can be corrected by machine grinding a new point on the drill. Other causes include a burr kicked up on the flutes, metal chips welding to the flutes due to insufficient lubrication.

5. An improperly ground drill bit will grab in the material causing the workpiece to ride up on the drill or causing the drill bit to gouge into the material. By slightly dulling the cutting edge on the point this can be prevented when cutting brass and some plastics.

6. The point of a drill will follow the path of least resistance. If there is no pilot hole the drill may walk off a true line in a deep cut. The pilot hole gives the larger drill a path to follow. Of course the pilot must be straight and accurately located.

DUTY: PERFORMING MILLING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 156

TASK: Clean and lubricate milling machine.

CONDITIONS: A milling machine, lubricants and the following tools and equipment:

Brush
Grease gun
Manufacturer's manual
Oil can
Personal safety equipment
Screwdriver
Wiping rags.

STANDARD: When completed, oil level gages must show full. All grease fittings must be lubricated to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Burghardt, et al. **Machine Tool Operation.** Part II, pp. 127-169.

PERFORMANCE GUIDE

1. Lock out milling machine power.
2. Consult manufacturer's manual for lubrication points and specifications.
3. Wipe clean all finished surfaces (ways, table, slides attachments/accessories).
4. Wipe grease fittings/lubrication point clean.
5. Select lubricants as per manufacturer's specifications.
6. Fill oil reservoirs.
7. Lubricate grease fittings and oil points.
8. Check oil level gages and fill to specifications.
9. Unlock power.
10. Start milling machine.
11. Recheck oil level sight gages.
12. Turn off milling machine.

ENABLING OBJECTIVES

Use safety procedures when working with electricity.
Use standard procedures for general maintenance of equipment.
Identify grease and oil fittings.
Determine correct lubricant.
Use standard preventive maintenance techniques and procedures.

PERFORMANCE OBJECTIVE V-TECS 156

LEARNING ACTIVITIES

1. Read handbook on electrical safety. Write a complete description of the proper procedures for electrical safety when working on any powered equipment.
2. Attend a lecture on electrical safety given by representative speaker from local power company.
3. Participate in class discussion of safety practices to be followed at all times.
4. Practice lockout procedures on various types of equipment.
5. Read manufacturer's manual concerning general maintenance of the equipment. Describe the standard procedures recommended on general care of the equipment. Read section concerning lubrication and select the proper lubricants for the equipment. Explain reason for selections.
6. Participate in class discussions on preventive maintenance procedures commonly followed in industrial plants.
7. Attend a lecture/demonstration given by a representative speaker from a local industrial maintenance shop or department.
8. Tour an industrial plant with the maintenance supervisor. Discuss why and how of maintenance procedures.
9. Review section on lubrication in textbook Industrial Maintenance, pp. 56-64.
10. Practice lubricating all types of equipment available in school shops.

RESOURCES

Equipment maintenance manuals supplied by manufacturers.

Textbook. **"Industrial Maintenance,"** Wireman. Chapter 5, **"Lubrication,"** pp. 56-64.

Textbook, **"General Industrial Machine Shop,"** Johnson. Section 1, **"Introduction To Machine Shop Practices,"** Unit 2, pp. 19-24.

OSHA, **"Checklist for General Industry,"** S. C. Department of Labor. **"Personal Equipment,"** pp. 6-7. **"Special Industries and Electrical,"** pp. 12-14.

Textbook, **"Developing Shop Safety Skills,"** Jacobs and Turner.

Text/workbook, **"Safety for the Industrial Student,"** Woodburn, **"Safety Handbook,"** prepared by the State Department of Education and Clemson University.

Material available from lubricant manufacturers.

Ronan, W., Home and Shop Safety Series, **"Using Power Tools," "Personal Safety."**

Textbook. **Industrial Maintenance,** Wireman, chapter 5, "Lubrication," pp. 56-64.

EVALUATION

1. Why is preventive maintenance so important in any shop facility?
2. List 3 probable failures caused by improper or inadequate lubrication.
3. List 3 common methods used to lubricate equipment.

Evaluation Continued

4. Why is grease better than oil in certain applications?
5. List the steps to be followed when lubricating any machine.

Answers

1. Preventive maintenance is important because it provides the maintenance people a way to keep a close check on the condition of their equipment. A regular monthly inspection, cleaning, and lubrication of each machine is scheduled and carried out. The machine is closely checked for damage and wear while it is being serviced. Any possible problem may be spotted and repaired before it becomes a major breakdown. This system will save down time on equipment, thus increasing productivity, the most important thing in industry today.

2. a. Shafts may freeze to bearing surfaces or cause the bearing to distort due to heat caused by friction.
   b. Rapid wear will cause spindles and drive shafts to run untrue or wobble, causing excessive wear on bearings and sleeves.
   c. Corrosion (rust), the main enemy of all machinery will result if the protective layer of grease or oil is not maintained.

This short list is only a few of the many possible answers to this question. Lubrication is the primary protection of all moving, mated parts. Other acceptable answers include:

   a. Prevent friction (heat, wear).
   b. Reduce metal to metal contact, preventing wear.
   c. Provide a metal separating wedge of lubricant, which dampens shock loads.
   d. Dissipate heat.
   e. Prevent rust and corrosion.
   f. Barrier against contamination.

3. a. Manually: The man with the hand operated grease gun or hand oiler is the best, and most thorough method of lubricating any piece of equipment.
   b. Gravity or drip: Most commonly used on slowly operating equipment. An oil cup is filled and the lubricant drips onto the parts to be lubricated.
   c. Bath method: The part or parts to be lubricated are partially submerged in a bath of lubricant. As they operate, the lubricant is carried to all other parts of the system.

There are other methods suggested and these are not the only answers. Others listed are:

   a. Splash
   b. Pressure.

Evaluation Continued

4. Grease, being a thicker more sticky substance, will cling more effectively to the surfaces it is supposed to lubricate. Thus it will stay where it is placed. Oil will run off or be thrown off when the equipment is operated. Selection of the proper lubricant is very important for this reason alone.

5. A suggested procedures lists.

1. Make proper use of personal safety equipment.
2. Follow established lockout routine before doing any work.
3. Clean, oil and grease fittings prior to applying lubrication.
4. Check machine for damage. Repair or replace broken/damaged fittings.
5. Clean and inspect all working surfaces for damage or excessive wear.
6. Check for worn or damaged drive belts. Repair or replace if required.
7. Refer to manufacturer's manual for proper lubricants to be used and locations of lubrication points.
8. Apply sufficient lubricant to each lubrication point and wipe clean before moving to next.
9. Apply a light coat of oil to all exposed, bare metal surfaces.
10. Check for spills and drips and general clean-up before moving to next machine.
11. Remove lockout device and turn power back on according to established shop procedures.

DUTY: PERFORMING MILLING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 157

TASK: Change coolant in milling machine.

CONDITIONS: A milling machine, specifications, water, coolant additive and the following tools and equipment:

Adjustable wrench
Coolant pail
Milling machine manual
Personal safety equipment
Screwdriver
Small hand or power pump.

STANDARD: When completed, the coolant must flow in a steady stream, be free from dirt and grit and must contain enough additive to prevent rusting of workpiece or milling machine in accordance with specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Burghardt, et al. **Machine Tool Operation**, part II, pp. 127-169.

PERFORMANCE GUIDE

1. Turn on main power source of milling machine.
2. Place pail under coolant hose nozzle.
3. Turn on coolant pump and pump coolant from reservoir until empty.
4. Flush coolant system with fresh water.
5. Turn off coolant pump.
6. Turn off/lock out main power source of milling machine.
   NOTE: Test for "off" condition.
7. Wipe clean coolant reservoir. Use scraper if necessary.
8. Refill coolant reservoir with mixture of water and coolant additive.
9. Unlock power.
10. Start machine. Check for flow of coolant and operation of control valve or petcock.

ENABLING OBJECTIVES

Use safety procedures when working on any electrically powered tool.
Use standard procedures for general maintenance of equipment.
Identify coolants and coolant additives.

PERFORMANCE OBJECTIVE V-TECS 157

LEARNING ACTIVITIES

1. Read handbook on electrical safety. Write a complete description of the proper procedures for electrical safety when working on any powered equipment.
2. Attend a lecture on electrical safety given by representative speaker from local power company.
3. Participate in class discussions of safety practices to be followed at all times.
4. Practice lockout procedures on various types of equipment.
5. Read manufacturer's manual concerning general maintenance of the equipment. Describe the standard procedures recommended for general care of the equipment. Read section concerning coolants and coolant additives for the equipment. Explain reason for selections.
6. Participate in class discussion on preventive maintenance procedures commonly followed in industrial plants.
7. Attend a lecture/demonstration given by a representative speaker from a local industrial maintenance shop or department.
8. Tour an industrial plant with the maintenance supervisor. Discuss why and how of maintenance procedures.
9. Review Information Sheet on Changing Coolants describing a standard procedure to be followed when changing coolants in any machine - Appendix L.
10. Practice changing coolants in the equipment available in the school shops.

RESOURCES

Equipment maintenance manuals supplied by manufacturers.
Textbook. **"Industrial Maintenance,"** Wireman, chapter 5, **"Lubrication,"** 56-64.
Textbook, **"General Industrial Machine Shop,"** Johnson. Section 1, **"Introduction To Machine Shop Practices,"** unit 2, pp. 19-24.
OSHA, **"Checklist for General Industry,"** S. C. Department of Labor. **"Personal Equipment,"** pp. 6-7. **"Special Industries and Electrical,"** pp. 12-14.
Textbook, **"Developing Shop Safety Skills,"** Jacobs and Turner.
Text/workbook, **"Safety for the Industrial Student,"** Woodburn and Clemson University.
Material available from coolant manufacturers.
Ronan, W., Home and Shop Safety Series: **"Personal Safety," "Using Power Tools."**
Information Sheet Appendix L - (Changing Coolants)

EVALUATION

Questions

1. Why is it important that coolants be changed regularly in milling machines?
2. What would be the result if plain water was used as the coolant in a milling machine?
3. What is "water soluble oil?"
4. What is the purpose of an anti-bacteria agent in the coolant?
5. List the procedures to be followed when changing coolants in any machine.

Answers

1. Coolants should be changed regularly because they can become contaminated with foreign materials, and/or bacteria. Proper coolant mixtures are usually white or light blue in color and contain only water, water-soluble oil, and an anti-bacterial agent. In use, the coolant will become mixed with residue from the material being cut, oil and other types of cutting fluids used when the coolant is not used, and bacterial growth may occur if tanks are not cleaned regularly causing unpleasant odors, possibility of infections and skin problems, etc.

2. Plain water used as a coolant would soon cause the machine to rust. All metal working machines depend on the coolant to perform several functions. It provides a way to carry heat away from the cutter, it carries the residue of the cut away from the cutter as well. The coolant provides a lubricant for the cutter so that it will cut freely and not bind. It provides a corrective coating to the workpiece, cutter, and machine parts to prevent corrosion when properly mixed. Water alone would only cool the cutter and carry the residue from the cut away. It would not cool the cutter in any way and might even cause binding. Any carbon steel material coming into contact with the water would rust quickly. Imagine, the work piece, cutters, table top, gears and operating system of the machine all rusted out the next day, if plain water was the only coolant used.

3. Water-soluble oil is an oil based chemical designed to be mixed with water so that it might be used as a cutting coolant/lubricant.

4. Anti-bacterial agents are used in coolant tanks to prevent the growth of bacteria which may be harmful to the machine operator. They also prevent the offensive smell caused when some varieties of bacteria grow in coolants.

5. Refer to next page, or the information sheet on changing coolants.

PERFORMANCE OBJECTIVE V-TECS 157

Evaluation Continued

The standard procedures to be followed are listed below. These rules hold for any machine using coolants.

1. Turn on Power.
2. Using the pump in the machine, pump all coolant (all the pump will pick up), into a bucket, 55 gal. drum or into drain system. Check to see if all coolant has been removed from reservoir.
3. Flush coolant system with fresh water. Use a hose or add water with buckets until water comes out clear and clean.
4. TURN OFF ELECTRIC POWER, LOCK OUT, and TAG.
5. Clean reservoir tank. Scrape all residue from the tank and wipe clean if possible.
6. Check return systems. Clean inlets, check for leaks and broken or damaged hoses.
7. Refer to manufacturer's manual for the recommended coolant and coolant additives.
8. Mix proper amounts of coolant, additives and, if required, water.
9. Pour sufficient amount into reservoir to insure pump inlet is under surface.
10. Remove lock out and turn on power.
11. Using the system pump to provide circulation, pour remaining coolant mixture into reservoir and allow to cycle through the system.
12. Check for leaks or stoppage of flow thru returns.
13. Clean floors of all spills.
14. Remove tag from power to complete.

Note: An additive to prevent bacterial growth is recommended as well as a disinfectant. This will prevent strong, unpleasant odors.

DUTY: PERFORMING MILLING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 158

TASK: Mill angles.

CONDITIONS: A workpiece, specifications for milling angle(s), coolant and the following tools and equipment:

Angle cutters/milling cutters (sharpened)
Dial indicator
Hand file
Jo blocks (gage locks)
Lead hammer or mallet
Machinery's handbook
Micrometer
Milling machine(s) w/attachments/accessories
Personal safety equipment
Sine bar
Vernier bevel protractor.

STANDARD: When completed, surface must be smooth and free from chatter marks. Angle must be within tolerance for specifications of ± 5 minutes.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 2, pp. 150-153.

PERFORMANCE GUIDE

1. Identify material for selection of cutting speeds and feed.
2. Determine/analyze angle to be milled.
3. Determine/select milling machine to use.
4. Analyze select approach method/set-up/attachments. (Tilting table, indexing head, universal milling attachments, sine plate, angle the head, angle cutter).
5. Mount and align table vise.
6. Secure workpiece in table vise.
7. Select/mount cutter.
8. Position workpiece to cutter.
9. Secure table locks.
10. Start milling machine.
11. Select/set spindle speed.
12. Select/set table feed.
13. Engage spindle speed control.
14. Apply coolant.
15. Engage table feed control.
16. Mill angle.
17. Disengage table feed control.
18. Disengage spindle speed control.

Performance Guide Continued

19. Turn off coolant.
20. Check surface to specifications. Make adjustments and mill as necessary.
21. Remove workpiece.
22. Turn off machine.
23. Deburr workpiece where necessary.
24. Recheck angle and surface to specifications.
25. Remove cutter.

ENABLING OBJECTIVES

Use personal safety rules.
Use milling machines safety rules.
Use measuring tools.
Use jo-blocks (gage locks).
Use special set up tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for cutting speeds, feeds, and cutter selection.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setups on milling machine operations. Write answers to questions at end of chapter.
2. Participate in classroom discussion on milling operations. (Reference material- student handout and written homework).
3. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
4. Participate in a class demonstration of how to use the protractor head on a combination square set, to set up a workpiece on a specific angle to the typical accuracy of the combination square set. (about +/- 1 Deg.)
5. Practice setting workpieces at various angles using the protractor attachment on a combination square set.
6. Observe presentation by instructor of proper procedures for setting up and using the sine bar.
7. Practice setting up accurate angles using a sine bar under instructor supervision.
8. Observe presentation by instructor of proper procedues for using angle blocks to set up accurate angles.
9. Practice setting up accurate angles using angle block under instructor supervision.

Learning Activities Continued

10. Set up various workpieces using each of the methods for setting angles accurately. Cut the angle on the workpiece and check accuracy using methods approved by the instructor.
11. Set up and cut accurate angles on a workpiece to print specifications. Accuracy and finish must conform to industry standards.

RESOURCES

Lasco et al. **"Machine Shop Operations and Setups."** Chapter 9, **"Milling Machines: Types, Construction, Accessories and Attachments,"** pp. 279-306. Chapter 10, **"Milling Machines: Milling Cutters, Setups, and Operations,"** pp. 307-360. Chapter 2, **"Measuring Tools: Semi-Precision and Precision."** pp. 9-49.

Johnson. **"General Industrial Machine Shop."** Section 9, **"Machining Metal with Milling Machines,"** Units 75-76, 77, 78, 79. 80, 81, 82 83, 84, 85, pp. 415-474. Section 1, **"Introduction to Machine Shop Practices,"** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129.

Olivo et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

EVALUATION

Questions

1. What is a sine bar? What is its primary use?
2. How are angle blocks related to gage blocks?
3. Describe a method of set up using a protractor head on a combination square set. A sine bar. Angle blocks.
4. What is a bevel protractor?
5. List 4 possible methods for cutting accurate angles using a milling machine.

Answers

1. A sine bar is a special tool used for measuring angles and location work at a desired angle to some other surface of line. It is made of hardened and ground steel. It has 2 cylinders attached near each end. These cylinders are ground to exactly the same diameter, mounted on the same centerline, and located exactly 5, 10, or 20 inches apart. The tool uses the trigonmetric function, SINE.

   Sine bars are used along with gage blocks and indicators to measure angles with extreme accuracy and to help the machinist set angles to be cut with great accuracy.

Evaluation Continued

2. Angle blocks are exactly the same thing as gage blocks except that they are precision ground to exact angles. They are used to set up angles to be cut and they are used to measure and compare angles which have been cut, primarily a tool used in the inspection room.

3. A protractor head is supplied with the standard combination square set. This tool can easily be used to set a workpiece to any angle and can also be used to measure angles. A method for making a set up to cut and angle using a protractor head might be as follows:
   a. Set protractor head to the desired angle and insert the 12" scale supplied with the combo square set.
   b. Lightly clamp the piece to be set on the angle in a holding device.
   c. Using the protractor resting on the reference surface or line, adjust the workpiece using the edge of the 12" scale as a reference surface. When alignment is set, securely tighten clamps, vise or other holding device. Recheck setting before beginning to cut.
   d. After cutting is completed, use the protractor to check the accuracy of the angular surface after deburring the piece.

This is a rough outline of one possible sequence of operations. The instructor is encouraged to make his own instruction sheets and to teach his own tried and proven methods.

4. A bevel protractor (vernier bevel protractor) is a precision measuring tool designed to provide the inspector with an accurate measuring tool which can be used to check angles with the same accuracy as a micrometer can check diameters.

5. A list of some different ways to cut angles on a mill:
   a. Tilt the head.
   b. Tilt the workpiece in a vise.
   c. Use a tilting fixture or vise.
   d. Use a special cutter with the desired angle ground on the cutting edges.

This is by no means all the ways. Instructors should develop their own lists based on their experience.

DUTY: PERFORMING MILLING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 159

TASK: Mill horizontal/vertical surfaces.

CONDITIONS: A workpiece, specifications for milled horizontal or vertical surfaces, coolant and the following tools and equipment:

Feeler gage
Ground parallel bars
Hand file
Lead hammer or mallet
Machinery's handbook
Milling cutters (sharpened)
Milling machines(s) (horizontal/vertical w/accessories/attachment(s)
Milling machine manual
Outside micrometer
Personal safety equipment
Surface plate
12" steel rule.

STANDARD: When completed, surfaces must be smooth and flat to within .005". Dimensions of surfaces must be within tolerances of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Burghardt, et al. **Machine Tools Operation**, part II, pp. 214-249.

PERFORMANCE GUIDE

1. Identify/material for selection of cutting speeds and feed.
2. Select milling machine (horizontal or vertical).
3. Analyze/select approach method/set-up.
4. Mount and secure horizontal/vertical milling attachment.
5. Secure workpiece in vise.
6. Select/mount milling cutter. (End mill/face cutter)
7. Turn on machine.
8. Position workpiece to cutter.
9. Secure table and/or head clamps.
10. Select/set cutter speed.
11. Select/set table feed.
12. Engage cutter speed control.
13. Start cut manually.
14. Engage table feed control.
15. Apply coolant.
16. Mill horizontal/vertical surface to specifications.
17. Disengage feed control.
18. Disengage cutter speed control.
19. Turn off coolant flow.
20. Remove workpiece from vise.

Performance Guide Continued

21. Turn off machine.
22. Deburr edges of workpiece.

ENABLING OBJECTIVES

Use personal safety rules.
Use milling machines safety rules.
Use measuring tools.
Use layout tools and techniques.
Use charts and tables for cutting speeds, feeds, and cutter selection.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setups on milling machine operations. Write answers to questions at end of chapter.
2. Participate in classroom discussion on milling operations. (Reference material - student handout and written homework)
3. Attend a lecture presentation on cutting methods and techniques. Participate in question and answer period at end of presentation.
4. Observe presentation by instructor of proper procedures for setting up and using the various types of common cutters used for standard milling operations.
5. Participate in a demonstration and lecture on the proper set up and use of the many different types of milling cutters available. Instructor to demonstrate some techniques and students to perform some techniques under instructor supervision while remaining class observes.
6. Practice setting up and cutting surfaces and sides using common cutters under instructor supervision.
7. Set up various workpieces and machine to required shape using various milling cutters as required. Surface finish and dimensions are to meet or exceed industry standards. Instructor to provide inspection and approval of finished work.

RESOURCES

Lasco et al. **"Machine Shop Operations and Setups."** Chapter 9, **"Milling Machines: Types, Construction, Accessories and Attachments,"** pp. 279-306. Chapter 10, **"Milling Machines: Milling Cutters, Setups, and Operations,"** pp. 307-360. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Johnson. **"General Industrial Machine Shop."** Section 9, **"Machining Metal With Milling Machines,"** Unit 75, 76, 77, 78, 79. 80, 81, 82, 83, 84, 85, pp. 415-474. Section 1, **"Introduction to Machine Shop Practices,"** Unit

Resources Continued

6, pp. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.
Olivo et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Ronan, William. Home and Shop Safety Series: **"Personal Safety" "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.
Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

EVALUATION

1. Given a blueprint, stock, milling cutters and milling machine, machine the workpiece to specified shape. Surface finish and dimensional accuracy must meet print specifications or industry standards as stated.

Questions

1. What are parallels? What is their advantage when machining parts in a milling machine?
2. Describe an end mill.
3. List some special types of milling cutters commonly used.
4. List 3 ways to hold a workpiece on the table of a milling machine.
5. Describe a set up procedure that will produce an accurate, square finished workpiece.

Answers

1. Parallels are precision ground pieces of steel, usually in matched pairs. Their opposite surfaces are ground parallel and, depending on the type of set, either two or four surfaces are finished. If all four surfaces are finished, adjacent sides will be accurately square with each other.
   Parallels can be used to support the work in a vise when the height of the work will not extend above the vise jaws. The opposite sides being parallel will assure that the work is sitting flat when resting on them in the vise.
   Parallels have many uses, all of which relate to their parallel sides. They can be used as fixtures, spacers, supports, actual measuring tools, and numerous other applications.

2. An end mill is a cutting tool.
   Primarily used on milling machines. It is made of high speed steel or carbide and is used to cut and shape metal, plastics, and almost any other carbide and is used to cut and shape metal, plastics, and almost any other type of material commonly used to manufacture useful items. End mills have cutting teeth on their sides (periphery) and also on their ends (bottoms). This provides the milling machine operator with a tool which can cut not only on its sides but also on the bottom. This way the operator can machine both horizontal and vertical surfaces using the same tool. They are manufactured in almost every common size and can have from 2 to 6 or more cutting flutes.

Evaluation Continued

3. Some special types of milling cutters are:
   Ball end, end mills
   Radius cutters, internal and external
   Dovetail cutters
   Woodruf key cutters, (for cutting key slots)
   Angle cutters, single and double
   Shell end mills, slab mills
   Side milling cutters
   Saws, fly cutters
   Gear hobs, thread cutters.
   The list can go on and on. Every possible application could have a special cutter.

4. Most milling machines are designed so that a variety of work holding methods can be used. Some of them include:
   a. A fixed machine vise, a swivel machine vise, and a tilting swivel machine vise;
   b. Angle plates;
   c. A dividing head, index head with center;
   d. Clamps. Attaching the work directly to the table of the machine;
   e. Rotary table.

Any combined applications of the above i.e, angle plate on a rotary table.

5. A method for producing square workpieces might be as follows:
   a. Clean table surface and indicate head to make sure it is perpendicular to the table.
   b. Carefully mount a machine vise on the table.
   c. Indicate the fixed jaw parallel with the axis of the machine. Also indicate the fixed jaw to be sure it is perpendicular to the table.
   d. Place the workpiece in the vise and clamp securely.
   e. Machine the top surface flat and smooth being sure to cut only enough to clean the surface.
   f. Remove the workpiece from the vise and carefully file the burrs and set aside.
   g. Clean the vise thoroughly.
   h. Replace the workpiece in the vise with the finished face against the fixed jaw. Use a round piece of stock behind the job to assure that the finished face rests flat against the solid jaw. (If the workpiece is simply clamped in the vise jaws it may be forced out of square by the remaining unfinished surfaces. (The round piece supplies all the holding pressure necessary while only touching at one continuous point along the face opposite the finished face).
   i. Machine the top surface until it cleans up and makes a square edge with the first side cut.
   j Again remove the piece and deburr with a file. Clean vise of all chips.

Evaluation Continued

k. At this point, use a solid square and check the two adjacent finished sides for square. If the set up was properly performed, the piece will be square.
l. Carefully place a method pair of parallels in the vise and lay the first finished surface on them. The adjacent finished surface should again be placed against the solid jaw. Back up with the round piece again before clamping.
m. Use a lead hammer, or other dead blow device to tap the workpiece until the parallels are tight, indicating that the finished surface is resting flat on them. Cut the third surface.
n. Remove, deburr, clean vise and again replace work in vise on parallels. Be sure to again tap with dead blow hammer to insure piece is flat on parallels. No need for the round piece this time as there are 3 finished surfaces now and 2 of them are parallel. Machine last surface to make part square.
o. Remove from vise and deburr. Check for square using a solid square. If nothing is out of square you may now begin to square the ends.
p. Replace the workpiece in the vise, on parallels. Instead of cutting with the bottom of the end mill as before, this time cut with the side of the end mill. Cut the unfinished end of the piece until it cleans up.
q. Remove work, deburr, clean vise, replace with other end out.
r. Reset tap and cut last end to complete cutting.
s. Remove and deburr to complete. Clean machine before leaving or going on to next part of the project.

It is understood that, if sizes are required, that the machinist will be checking after each cut to see that piece is not going to come out too small.

DUTY: PERFORMING MILLING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 160

TASK: Ream hole to size.

CONDITIONS: A metal workpiece with holes to be reamed, specifications for reamed holes and the following tools and equipment:

Church key
Lead hammer or mallet
Lubricant for reamer
Micrometer (outside)
Personal safety equipment
Print or specifications
Set of drills (sharpened)
Set of reamers
Telescoping gage.

STANDARD: When completed, the hole must have smooth finish and be within tolerance of specifications T.I.R. (total inch runout) of .0005".

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Identify material for selection for cutting speeds and feed.
2. Determine size of hole to be reamed.
3. Secure workpiece in vise.
4. Select/mount drill.
5. Position workpiece hole with drill.
6. Secure table locks.
7. Remove drill.
8. Select/drill reamer.
9. Start machine.
10. Select/set spindle speed.
11. Select/set rate of feed.
12. Engage spindle speed control.
13. Engage feed control. Lubricate as necessary.
14. Ream hole to specifications.
15. Disengage feed control.
16. Disengage spindle speed control.
17. Check reamed hole to specifications.
18. Remove workpiece.
19. Turn off milling machine.

PERFORMANCE OBJECTIVE V-TECS 160

ENABLING OBJECTIVES

Use personal safety rules.
Use milling machines safety rules.
Use measuring tools.
Use layout tools and techniques.
Use holding devices.
Use charts and tables for cutting speeds, feeds, and cutter selection.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Read textbook Machine Shop Operations and Setups, pp. 279-360 on milling machines and milling operations. Write answers to questions at end of chapter.
2. Participate in classroom discussion on milling operations. (Reference material - student handout, written homework)
3. Attend a lecture/demonstration on drill press operations (Reaming). Participate in question and answer period at end of presentation.
4. Set up and drill undersize holes to prepare for reaming practice.
5. Practice reaming procedures with instructor assistance.
6. Use reamers to accurately size predrilled holes to print specifications.
7. Working from a blueprint, lay out, center punch, hole locations. Set up on milling machine. Locate, drill and ream holes to print specifications. Present to instructor for evaluation.

RESOURCES

Lasco et al. **"Machine Shop Operations and Setups."** Chapter 9, **"Milling Machines: Types, Construction, Accessories and Attachments,"** pp. 279-306. Chapter 10, **"Milling Machines: Milling Cutters, Setups, and Operations,"** pp. 307-360. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Johnson. **"General Industrial Machine Shop."** Section 9, **"Machining Metal with Milling Machines."** Units 75, 76, 77, 78, 79, 80. 81, 82, 83, 84, 85, pp. 415-474. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129.

Olivo et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

PERFORMANCE OBJECTIVE V-TECS 160

EVALUATION

Questions

1. How is reaming different on a milling machine from reaming on a drill press?
2. What is the proper reamer to use when reaming on a milling machine.
3. Describe the major difference between a vertical milling machine and a drill press.
4. Describe a method for checking the accuracy of size in a reamed hole.
5. Why ream a hole?

Answers

1. Reaming on a milling machine is no different on a mill than on a drill press. The methods are exactly the same with the possible exception of having a variable feed rate available on the mill. The major difference is in the locating of the holes to be reamed. On a drill press, for the most part the mechanic must depend on his lay out skills and the accuracy of his center punched marks. On a milling machine, once properly set up, any hole locations can be set with micrometer precision using the graduated hand wheels on the table.

2. The standard machine reamer or the star reamer are the only types to be used on the mill. Most other reamers are for hand use and should not be used on any machine.

3. The major difference between a vertical milling machine and a drill press is the rigidity of the spindle assembly. A drill press does not have to allow for side pressure which the mill must have for end milling. Other features may include a power feed for the spindle, power feed to the table, and calibrated hand wheels on the table for accuracy of location. While some drill presses lack these features, some machines do have similar features. The strength of the spindle assembly is really the only obvious difference.

4. There are many methods for checking size in any hole. Some of the accepted methods are:
   a. Measuring with a small hole gage or telescoping gage and then verifying size with a micrometer,
   b. Pushing an accurately ground gage pin through the hole and judging tightness of fit. Gage pins come in sets of .001 steps, so any size within the range of the set can be accurately checked to .001.
   c. Larger holes can be checked with inside micrometers or verniers.
   d. Dial bore gages are used when highest accuracy is required.

5. Reaming is a quick and easy method for producing accurate sized, straight, smooth holes. It is much faster than boring and much easier than burnishing or honing. Where many holes must be made the same size, it is by far the fastest method.

PERFORMING TURNING OPERATIONS

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 161

TASK: Bore hole with lathe.

CONDITIONS: A workpiece with drilled or cored hole to permit boring, specifications of finished hole and the following tools and equipment:

Adjustable wrench
Boring bar and holder
Cutting holes (sharpened)
Engine lathe with attachments and accessories
Inside Calipers
Lathe manual
Machinery's handbook
Micrometer
Personal safety equipment
Steel scale
Telescope gages.

STANDARD: When completed, the hole must have smooth finish free of chatter marks and depth must be within ±1/64", the diameter within ±0.003", and the locations with ±0.010".

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 215-219.

PERFORMANCE GUIDE

1. Identify workpiece material for selection of cutting speeds and feed.
2. Chuck workpiece in lathe.
3. Select and mount cutting tool in boring bar and holder.
4. Align/adjust boring bar/holder/cutting tool to hole.
5. Select/set cutting speed/feed.
6. Turn on lathe.
7. Check tool alignment.
8. Rough bore hole. CAUTION: Adjust for eccentricity as needed.
9. Finish bore hole. Adjust speed/feed as necessary.
10. Shut off lathe.
11. Check bored hole for size with telescope gages and micrometer.
12. Remove cutting tool.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety tools.
Use grind lathe cutting tools.
Use measuring tools.

Enabling Objectives Continued

Use holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter Machine Shop Operations and Setups, pp. 151-255, 368-410.
2. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework)
3. View a movie on lathe operations (common operations on engine lathes).
4. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
5. Participate in a class discussion and demonstration on grinding lathe cutting tools (reference material, text book and handout).
6. Practice grinding lathe cutting tools with instructor assistance.
7. Attend a demonstration showing each of the common methods for holding workpiece in an engine lathe. (3 jaw chuck, 4 jaw chuck, collett, between centers, face plate, etc.)
8. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes General Industrial Machine Shop, pp. 222-316.
9. View a demonstration given by the instructor on how to remove and replace various workholding devices on the lathes in the shop.
10. Practice mounting various work holding devices on the machines in the shop.
11. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
12. Participate in a demonstration of set up procedures for aligning holes to be bored in a lathe, given by the instructor.
13. Practice setting up parts with holes to be bored. Note the use of the tail stock center and an indicator.
14. Bore holes to specified sizes using proper tools. Finished holes must be accurately located and machined to print specifications as to finish and size.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129.

Resources Continued

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments,"** pp. 151-179. Chapter 7, **"Engine Lathes" "Cutting Tools, Setups and Operations,"** pp. 180-225. Chapter 11, **"Producing Turning: Turret Lathes and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. Describe the use of an indicator when setting up a workpiece with a hole to be bored.
2. How can the dead center in the tailstock be useful when setting up work to be bored.
3. List the important measuring tools that should be used to insure accurate holes.
4. What is a boring tool? A boring bar?
5. What other operations can be performed on a lathe using the boring tool/bar?

Answers

1. An indicator should always be used to insure that the hole that is predrilled in the workpiece is located exactly on the centerline (axis) of the lathe before any boring is done. A series of steps to perform this operation might be as follows:
   a. Place the workpiece in a work holding device. (NOTE: The work holding device might be any one of several available. Look on sheets or in text for specific instructions for each different type).
   b. Snugly clamp the work piece. Do not tighten securely yet.
   c. Mount an indicator in the tool post and bring the finger (plunger, ball, foot) near the hole to be indicated. DO NOT TOUCH ANY PART OF THE HOLE WITH THE INDICATOR YET!
   d. Place the lathe in neutral and rotate the piece. Look to see if the hole edge appears to be the same distance away from the finger of the indicator as the piece rotates. If not, adjust until it appears to be the same all the way around.

Evaluation Continued

- e. Now place the finger of the indicator in contact with the inner surface of the hole. Note any variations and correct by adjusting the workpiece slightly until the same reading is obtained all the way around the hole. NOTE: If the hole appears not to be round then go for same readings 180 deg. apart in two places.
- f. Tighten the work securely in the holding device and recheck the hole with the indicator to make sure nothing moved.
- g. Remove indicator from tool post and mount boring tool to bore hole.

2. The dead center in a tail stock (or a live center) may be used to assure that the hole in a predrilled workpiece is close to being on center by simply placing the workpiece in the holding device and snugging it down. Bring the dead center up and into the hole to be centered. Adjust the workpiece until the center fits exactly or the gap around the center is the same all the way around. Securely clamp the workpiece to finish. (NOTE: This method is simply a short cut and should not be used for very accurate work. Always indicate to make sure before continuing).

3. Some useful measuring tools for checking holes for accurate diameter include:
   - a. Micrometer
   - b. Inside Micrometer
   - c. Verniers
   - d. Telescoping gages
   - e. Hole gages
   - f. Dial bore gages
   - g. Plug gages, pin gages.

4. A boring bar is a metal bar used to hold a cutting tool so that the inside diameters of holes may be bored in a lathe, mill, or drill press. Sometimes the tool itself might be called a boring bar.

5. a. Boring. Inside turning/facing.
   - b. Undercutting. Cutting grooves.
   - c. Internal threading.

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 162

TASK: Counterbore hole with lathe.

CONDITIONS: A workpiece with a hole that requires counterboring, specifications of finished counterbore and the following tools and equipment:

Boring bar (with 45° or 30° head)
Cutting tool bit (sharpened)
Depth gage
Engine lathe with attachments and accessories
Inside calipers
Lathe operator's manual
Machinery's handbook
Personal safety equipment.

STANDARD: When completed, the counterbore must be within tolerances of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 7-8.

PERFORMANCE GUIDE

1. Identify workpiece material for selection of cutting speed and feed.
2. Chuck workpiece in lathe.
3. Mount boring bar.
4. Select and mount cutting tool in boring bar and holder.
5. Adjust boring bar and carriage stops.
6. Select and set cutting speed of spindle.
7. Select and set rate of feed of carriage.
8. Turn on lathe.
9. Bore roughing cuts.
10. Counterbore to specifications. Adjust cutting speed and feed as necessary.
11. Shut off lathe.
12. Check diameter and depth to specifications. Remove burrs if necessary.
13. Remove cutting tool.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Use grind lathe cutting tools.
Use measuring tools.

PERFORMANCE OBJECTIVE V-TECS 162

Enabling Objectives

Use holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop and Operations and Setups, pp. 151-255.
2. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework)
3. View a movie on lathe operations (Common operations on engine lathes).
4. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
5. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
6. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
7. Practice mounting various work holding devices on the machines in the shop.
8. Practice mounting workpiece in each of the holding devices discussed. Note the differences as well as the similarities in each.
9. Participate in a demonstration of set up procedures for aligning holes to be bored in a lathe, given by the instructor.
10. Attend a demonstration and lecture on counterboring operations.
11. Participate in a class discussion and demonstration on boring and counterboring in a lathe. (Reference material, textbook and handout).
12. Practice boring and counterboring in a lathe with instructor assistance.
13. Attend a demonstration showing how to align a predrilled hole for counterboring in an engine lathe.
14. Practice setting up parts with hole to be bored. Note the use of the tail stock center and an indicator.
15. Bore holes to specified sizes using proper tools. Finished holes must be accurately located and machined to print specifications as to finish and size.
16. Practice counterboring holes to specific depth and diameter.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-216. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129.

PERFORMANCE OBJECTIVE V-TECS 162

Resources Continued

Lasco, et al. **"Machine Shop Operations and Setup."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments,"** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting tools, Setups and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions," "Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. Explain the differences in counterboring when working on a lathe, drill press or milling machine.
2. Describe the set up procedures for counterboring a predrilled hole on a lathe.
3. What is a counterbore?
4. What measuring tools, both precision and semi-precision, are considered necessary to adequately check a counterbore?
5. Why is concentricity important between the hole and the counterbore?

Answers

1. Counterboring in a lathe differs from counterboring in a milling machine or a drill press little or none. If care is taken when the work is set up in a holding device, then any of the accepted methods of producing a counterbore may be used. The method most used in a lathe would be boring the counter bore after machining hole, or bore the counterbore after aligning the hole carefully with the axis of the machine. Using a counterbore tool, set drill, end mill, or other accepted method would also be all right.

2. See next page for a possible sequence of operations.

3. A counterbore is:
   An enlargement of the diameter of a hole to a specific depth. This may be for the purpose of allowing the head of a screw or bolt to rest below a finished surface. It may simply be for clearance, or it may be for some other specified purpose as described in the job specifications.

4. A list of useful measuring tools might be as follows:
   a. Micrometers
   b. Inside micrometers
   c. Telescoping gages
   d. Hole gages.

Evaluation Continued

e. Depth micrometers
f. Depth gages
g. Combination square
h. Steel rule
i. Pin gages.
Etc. etc. etc.

5. If the counterbore is not concentric with the hole it may cause the head of the screw or bolt or other object placed in the hole to bind against the inside diameter of the counterbore. This could prevent the screw or bolt from being tightened properly, could cause the parts to misalign or cause the part to bind up and break or otherwise damage an assembly.

To counterbore a predrilled hole in a lathe, the following steps might be followed:

a. Select a lathe work holding device adequate to provide good support for the work piece, and ease of adjustment for alignment of the hole to be counterbored.
b. Mount the work holding device on the lathe.
c. Mount the workpiece in/on the workholding device and, using any acceptable method roughly align the hole to be counterbored with the axis of the machine and centered. Snug (DO NOT TIGHTEN AT THIS TIME) the work in/on the holding device.
d. Mount an indicator on the tool post and bring indicator finger into contact with the inside diameter of the hole.
e. Rotate the workpiece and adjust as necessary to obtain a uniform reading all the way around the hole. (NOTE: This will place the center of the hole on the center line of the machine spindle).
f. If counterbore must be perpendicular to the hole then further indicating must be done. A pin or test bar which fits snugly in the hole must be used. The bar is pushed all the way into the hole and then the indicator is moved along the side of the bar. If any deviation is noted the work must again be adjusted until the bar is both parallel to the long axis of the machine and, when rotated, on center.
g. Once these adjustments are made the work can be securely clamped. Check once more for alignment before removing the indicator from the machine.
h. Mount a suitable tool for performing the counterboring operation and proceed to bore the hole to specified diameter and depth. Check as you proceed until the specified dimensions are met.

Counterboring is used to enlarge a hole to a given depth for a cap screw or bolt head. The tool is similar to an end mill with the additon of a PILOT. The PILOT is a plug slightly smaller than the hole you wish to counterbore. PILOTS are interchangeable and can be swapped as necessary from cutter to cutter. Pilots can be made of scrap material when one of the right size cannot be found. Normally this will be .001 or less. Because of the large surface area the tool should be run slower than the drill.

PERFORMANCE OBJECTIVE V-TECS 162

Evaluation Continued

Counterboring is also an operation which can easily be performed on a lathe. By simply moving the boring tool over further, after finishing a hole, you can counterbore that hole to any size of depth you wish, and you can be sure that the c/bore will be exactly concentric with the hole because you never removed the piece from the machine before performing the operation.

(C/bore - std. abbreviation for counterbore)

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 163

TASK: Cut internal threads with lathe.

CONDITIONS: A workpiece, internal thread specifications, lubricant and the following tools and equipment:

Boring bar
Center gage and center drill
Engine lathe with attachments and accessories
Lathe manual
Machinery's handbook
Personal safety equipment
Scale
Thread plug gages
Tool bit ground to thread form.

STANDARD: When completed, threads must be free of burrs and cut to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 275-288, 294-297.

PERFORMANCE GUIDE

1. Identify material of workpiece for selection of drills, cutting speeds and feeds.
2. Chuck workpiece in lathe.
3. Face workpiece.
4. Center-drill workpiece.
5. Step-drill as necessary. Lubricate as necessary.
6. Bore hole to minor diameter of threads.
7. Set compound rest to specifications.
8. Mount and square boring bar using center gage.
9. Set up Quick-Change gear box.
10. Make thread dial selection.
11. Turn on lathe.
12. Cut threads to specifications.
13. Turn off lathe.
14. Check threads with thread plug edge.
15. Remove workpiece.
16. Remove tool bit.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Use grind cutting tools.

PERFORMANCE OBJECTIVE V-TECS 163

Enabling Objectives

Use measuring tools.
Use lathe holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setups, pp. 151-255, 368-410.
2. Read chapters on threads and threading. Write answers to questions at end of chapter.
3. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework)
4. View a movie on lathe operations (common operating on engine lathes).
5. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
6. Participate in a class discussion and demonstration on grinding lathe cutting tools. (Reference material, textbook and handout).
7. Practice grinding lathe cutting tools with instructor assistance.
8. Attend a demonstration showing each of the common methods for holding workpieces in an engine lathe. (3 jaw chuck, 4 jaw chuck, collett, between centers, face plate, etc.)
9. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
10. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
11. Practice mounting various work holding devices on the machines in the shop.
12. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
13. Participate in a demonstration of set up procedures for chasing threads both inside and outside on a lathe, given by the instructor.
14. Practice setting up parts to be threaded. Note: Be sure to use the center gage to set the threading tool. Note: Be sure to turn compound to 29.5 degrees before going too far with basic set up.
15. Observe demonstration of techniques for chasing threads on a lathe. (Chasing threads = cutting threads on a lathe with a single point cutting tool).
16. Practice chasing external threads of various pitches.
17. Attend a lecture on the importance of drilling or boring a properly sized hole before attempting to cut internal threads by any method.

Learning Activities Continued

18. Participate in a class discussion of the various methods used to find the proper minor/root diameters of threads in order to calculate the proper hole size for internal threads.
19. Practice chasing internal threads of various pitches.
20. Practice chasing left handed threads of various pitches, both inside and outside.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129. Section 4, **"Hand Tools and Benchwork."** Units 27, 28, pp. 185-200.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments,"** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting Tools, Setups and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines."** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49. Chapter 3, **"Bench Tools." "Hand Taps and Tapping,"** pp. 64-71.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart With Safety Suggestions." "Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. What is a center gage? Why is it so important when threading?
2. What is pitch? What is a pitch gage?
3. What is the difference between pitch and lead?
4. What is the advantage of turning the compound to 29.5 deg. instead of plunging straight into the work?
5. Why should the threading tool be accurately ground to a 60 deg. inc. angle?
6. Describe 2 methods for determining the proper sized hole for an internal thread.

Answers

1. A center gauge is a tool used for several purposes.
   a. It is used to set a threading tool perpendicular to the center line of the workpiece. (At 90 deg. to the center line)
   b. It is used as a gauge for grinding the proper shape point on a tool used for threading.

Evaluation Continued

2. Most simply stated, pitch is the distance from the top of one thread to the same point at the top of the next thread. Another way to state it is the distance between two adjacent threads.
   Lead is the distance that a point on one thread moves as the screw is rotated one full turn.
   Actually, these two terms describe the exact same thing and they are interchangeable as long as you are talking about single lead threads. They will differ when talking about multiple lead threads.
   These terms can be expressed in a formula as follows:
   Pitch = 1 in./threads per inch
   lead = 1 in./threads per inch
   (unless the thread is a multiple lead thread) then
   lead = 2 (double)
   3 (triple) x (1 in./threads per inch)
   4 (quad.)

3. The question is answered in #2.

4. The advantage gained when turning the compound to an angle of 29.5 degrees is ease in producing clean, properly shaped threads. As the properly ground threading tool is advanced into the work along this 29.5 degree angle only one side of the tool does the heavy cutting. The difference of 1 degree allows the trailing flank of the tool to shave that side of the thread, producing clean smooth surfaces. When you plunge straight into the work, equal sized cuts are made with both sides of the tool. This results in very heavy pressure on the cutting tool point and will not produce the clean smooth surface necessary for maximum strength.

5. An agreement between all manufacturers some years ago was made, that the American standard thread form would be 60 deg. included angle. With all form cutting, the only way to get an accurate shape is to grind the cutting tool to the desired shape. Since thread cutting is a form of specific form cutting, a tool ground to the proper shape is a must.

6. Two methods for finding the proper diameter of a hole to be threaded:
   a. The easy way is to check any tap drill chart for the tap drill size to be used to drill a hole to be tapped. Use this information to size the hole you wish to cut before tapping or chasing threads in a lathe. If there is no tap drill size given, you can find the tap drill size nearest to the thread size you wish to cut. Subtract the tap drill size from the major diameter of the listed tap to determine the double depth of the thread. Then subtract this double depth from the thread size you wish to cut. The results of this computation will give you an acceptable hole diameter for the internal thread you wish to cut.
   b. A more accurate way is to calculate the double depth of the thread you want to cut and add 10%. Subtract this result from the major diameter of the thread you want to cut. This will be your hole diameter.

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 164

TASK: Cut external threads with lathe.

CONDITIONS: A workpiece specification for external threads, thread cutting oil and the following tools and equipment:

Center drill
Engine lathe with attachments and accessories
Lathe manual
Machinery's handbook
Micrometer
Personal safety equipment
Thread center gage
Tool cutting bits (ground to proper thread form).

STANDARD: When completed, threads must be free of burrs and cut to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practices.** Vol. 1, pp. 275-294.

PERFORMANCE GUIDE

1. Identify workpiece material for selection of drill, cutting speeds/feeds.
2. Mount workpiece on faceplate or chuck.
3. Prepare workpiece for cutting threads (facing, turning, center drilling as needed).
4. Mount workpiece for cutting threads between centers if necessary.
5. Select/speed/feed for cutting threads.
6. Set up Quick-Change gear box.
7. Set compound rest to specifications.
8. Select/mount/align cutting tool.
9. Make thread dial selection.
10. Turn on lathe.
11. Trial run tool before cutting as necessary.
12. Cut threads.
13. Stop lathe.
14. Check to specifications.
15. Remove workpiece and cutting tool.

ENABLING OBJECTIVES

Use personal safety tools.
Use lathes safety rules.
Grind lathe cutting tools.
Use measuring tools.

PERFORMANCE OBJECTIVE V-TECS 164

Enabling Objectives Continued

Use lathe holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setups, pp. 151-255, 368-410.
2. Read chapters on threads and threading. Write the answers to questions at end of chapter.
3. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework).
4. View a movie on lathe operations (common operations on engine lathes).
5. Attend a lecture/slide (film-strip) presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
6. Participate in a class discussion and demonstration on grinding lathe cutting tools. (Reference material, textbook and handout).
7. Practice grinding lathe cutting tools with instructor assistance.
8. Attend a demonstration showing each of the common methods for holding workpieces in an engine lathe. (3 jaw chuck, 4 jaw chuck, collett, between centers, face plate, etc.)
9. Study chapter in textbook showing the removal and installation of work holding devices on engine lathe - General Industrial Machine Shop, pp. 222-316.
10. View a demonstration given by the instructor on how to remove and replace various work holding devices on the machines in the shop.
11. Practice mounting various work holding devices on the machines in the shop.
12. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
13. Participate in a demonstration of set up procedures for chasing threads both inside and outside on a lathe, given by the instructor.
14. Practice setting up parts to be threaded. Note: Be sure to use the center gage to set the threading tool. Note: Be sure to turn compound to 29.5 deg. before going too far with basic set up.
15. Observe demonstration of techniques for chasing threads on a lathe. (Chasing threads = cutting thread on a lathe with a single point cutting tool).
16. Practice chasing external threads of various pitches.
17. Practice chasing internal threads of various pitches.
18. Practice chasing left handed threads of various pitches, both inside and outside.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129. Section 4, **"Hand tools and Benchwork."** Units 27, 28, pp. 185-200.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments,"** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting Tools, Setups, and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathe and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision,"** pp. 9-49. Chapter 3, **"Bench Tools." "Hand Taps and Tapping,"** pp. 64-71.

Olivo et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. What is a center gage? Why is it so important when threading?
2. What is pitch? What is a pitch gage?
3. What is the difference between pitch and lead?
4. What is the advantage of turning the compound to 29.5 deg. instead of plunging straight into the work?
5. Why should the threading tool be accurately ground to a 60 deg. inc. angle?

Anwers

1. A center gauge is a tool used for several purposes.
   a. It is used to set a threading tool perpendicular to the center line of the workpiece. (At 90 deg. to the center line)
   b. It is used as a gauge for grinding the proper shape point on a tool used for threading.

2. Most simply stated, pitch is the distance from the top of one thread to the same point at the top of the next thread. Another way to state it is the distance between two adjacent threads.
   Lead is the distance that a point on one thread moves as the screw is rotated one full turn.
   Actually, these two terms describe the exact same thing and they are interchangeable as long as you are talking about single lead threads.
   They will differ when talking about single lead threads. These terms can be expressed in a formula as follows:
   pitch = 1 in./threads per inch
   lead = 1 in./threads per inch
   (unless the thread is a multiple lead thread) the

Evaluation Continued

lead = 2 (double)
3 (triple) x (1 in./threads per inch)
4 (quad)

3. The question is answered in #2.

4. The advantage gained when turning the compound to an angle of 29.5 degrees is ease in producing clean, properly shaped threads. As the properly ground threading tool is advanced into the work along this 29.5 degree angle only one side of the tool does the heavy cutting. The difference of 1 degree allows the trailing flank of the tool to shave that side of the thread producing clean smooth surfaces. When you plunge straight into the work, equal sized cuts are made with both sides of the tool. This results in very heavy pressure on the cutting tool point and will not produce the clean smooth surfaces necessary for maximum strength.

5. An agreement between all manufacturers some years ago was made, that the American standard thread form would be 60 deg. included angle. With all form cutting, the only way to get an accurate shape is to grind the cutting tool to the desired shape. Since thread cutting is a form of specific form cutting, a tool ground to the proper shape is a must.

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 165

TASK: Die cut threads with lathe using die head/stock/wrench.

CONDITIONS: A metal workpiece, thread and chamfer specifications, cutting oil and the following tools and equipment:

Die head/stock/wrench
Dies
Engine lathe with attachments and accessories
Lathe manual
Machinery's handbook
Micrometer
Ring thread gage and nut
Safety thread gage and nut.

STANDARD: When completed, threads must be free of burrs and die cut to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Identify material of workpiece for selection of cutting speeds and feed.
2. Chuck workpiece in lathe.
3. Prepare workpiece for threading (turning, facing, chamfering) to specifications.
4. Select/mount die in die head/wrench/stock.
5. Align die to workpiece and secure die head/wrench/stock from turning.
6. Select/set spindle speed for threading.
7. Start lathe.
8. Thread to specifications by applying pressure on tailstock. Protect as necessary. Lubricate as necessry. Stop and reverse spindle to clear die of cuttings as necessary.
9. Stop lathe.
10. Check threads to specifications with thread gage and nut.
11. Remove workpiece.
12. Remove die head component.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Use grind lathe cutting tools.
Use measuring tools.
Use lathe holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 165

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setups, pp. 151-255, 368-410.
2. Read chapters on threads and threading. Write answers to questions at end of chapter.
3. Participate in classroom discussion on lathe operations. (Reference material - student handbook and written homework)
4. View a movie on lathe operations (common operations on engine lathes).
5. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
6. Participate in a class discussion and demonstration on grinding lathe cutting tools. (Reference material, textbook and handout).
7. Practice grinding lathe cutting tools with instructor assistance.
8. Attend a demonstration showing each of the common methods for holding workpieces in an engine lathe. (3 jaw chuck, 4 jaw chuck, collett, between centers, face plate, etc.)
9. Study chapter in textbook showing the removal and installation of work holding devices on engine lathe - General Industrial Machine Shop, pp. 222-316.
10. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
11. Practice mounting various work holding devices on the machines in the shop.
12. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
13. Particpate in a demonstration of set up procedures for chasing threads both inside and outside on a lathe, given by the instructor.
14. Practice setting up parts to be threaded. Note: Be sure to use the center gage to set the threading tool. Note: Be sure to turn compound to 29.5 deg. before going too far with basic set up.
15. Observe demonstration of techniques for chasing threads on a lathe. (Chasing threads = cutting threads on a lathe with a single point cutting tool).
16. Practice chasing external threads of various pitches.
17. Practice chasing internal threads of various pitches.
18. Practice chasing left handed threads of various pitches, both inside and outside.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129. Section 4, **"Hand Tools and Benchwork."** Units 27, 28, pp. 185-200.

Resources Continued

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments,"** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting Tools, Setups and Operations"**, pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49. Chapter 3, **"Bench Tools." "Hand Taps and Tapping,"** pp. 64-71.
Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**
Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58

EVALUATION

Questions

1. What is the difference between a conventional threading die and a pipe threading die?
2. What is the purpose of the chamfer on the end of the piece to be threaded?
3. What is the major difference between a standard cutting die and an acorn die?
4. What is the rule for achieving a proper fit when threading with a standard pipe die?
5. Describe a threading method using a die on a lathe.

Answers

1. There is no real difference between standard threading dies and pipe threading dies. Both are made the same way. Of course the pipe thread has the typical 3/4 in./ft. taper common to most pipe threads, where the standard die is straight. The pipe die might also have a collar designed to assure the thread will be cut square with the axis of the work.

2. The chamfer on the end of the workpiece provides a "lead" for the die to start. It makes the die easier to start straight before making a full depth cut.

3. Most standard cutting dies are made with a method for adjustment provided. The most common is the "split" ring where one side of a round die is cut and a set screw inserted for some adjustment larger or smaller. The acorn die (square) is primarily used for sizing damaged threads and has no provision for adjustment. These dies should not be used for cutting full depth threads because they have no adjustment, and no clearance for the chips generated by heavy cutting.

Evaluation Continued

4. The rule for achieving proper fit with a pipe die is that the die be screwed on to the end of the pipe until the end of the pipe is even (flush) with the back face of the die.
5. A method for threading with a die on a lathe might be as follows:
   a. Securely mount the workpiece in a chuck or collett or other lathe holding device. Leave only the length to be threaded sticking out unsupported.
   b. Use a file or cutting tool to make a chamfer on the end to be threaded.
   c. Mount the die to be used in a holding device. (For lathe work, there are special holders designed for this work).
   d. Slow the lathe to a very slow number of rpm's. This will enable you to control the cutting action of the die.
   e. Using the tail stock as a steady rest for the die holder, bring the die into contact with the work and continue to push the die onto the chamfered end of the work until the die catches and begins to cut.
   f. Stop the machine, check to see if the die is started straight and that the thread is of proper size. If all right restart the die on the work, turn the lathe back on and, while preventing the die from rotating with the work, cut the threads to the proper length.
   g. Back the die off the work and check for proper class of fit. If the threads are too tight, adjust the die for a heavier cut and run it over the workpiece again.
   h. Deburr and clean off oil and grease to complete the threading process.

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 166

TASK: Drill hole with lathe.

CONDITIONS: A metal workpiece, specifications of hole, lubricant and the following tools and equipment:

Center drill
Drill holder (optional)
Engine lathe with attachments and accessories
Headstock chuck or faceplate
Lathe dog (optional)
Lathe operator's manual
Machinery's handbook
Personal safety equipment
Tailstock drill chuck or tapered shank drills
Tool post
Twist drill.

STANDARD: When completed, the hole should be free of burrs and chatter marks, and drilled according to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1 pp. 211-214.

PERFORMANCE GUIDE

1. Identify workpiece material for selection of cutting speeds/feeds.
2. Mount workpiece in chuck or on faceplate.
3. Face workpiece as necessary.
4. Select/set speed for center drilling.
5. Select/mount drill in tailstock using chuck or taper shank drill.
6. Start lathe spindle.
7. Center drill hole by applying pressure on tailstock.
8. Stop lathe. Select/mount drill.
9. Step drill hole by repeating steps #4 to #8 as necessary.
10. Shut off lathe.
11. Check hole to specifications.
12. Remove drill/attachments.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Use grind lathe cutting tools.
Use measuring tools.
Use holding devices.

PERFORMANCE OBJECTIVE V-TECS 166

Enabling Objectives Continued

Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setups, pp. 151-255, 368-410.
2. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework)
3. View a movie on lathe operations (common operations on engine lathes).
4. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
5. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
6. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
7. Practice mounting various work holding devices on the machines in the shop.
8. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
9. Participate in a demonstration of set up procedures for aligning holes to be drilled in a lathe, given by the instructor.
10. Attend a demonstration and lecture and on drilling operations.
11. Participate in a class discussion and demonstration on drilling and reaming in a lathe, (reference material, text book and handout).
12. Practice drilling and reaming in a lathe with instructor assistance.
13. Drill holes to specified sizes using proper tools. Finished holes must be accurately located and machined to print specifications as to finish and size.
14. Practice reaming holes to specific depth and diameter.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Measurement Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Cutting Tools, Setups and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-and Precision,"** pp. 9-49.

Resources Continued

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**
Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. List 3 methods of drilling which may be used when working on an engine lathe.
2. List 3 or more uses for the combination center-drill/c/sk when working on a lathe.
3. What is a taper shank drill? What is a sleeve? What is a drift key?
4. How is a Silver and Demming or Gorton drill different from standard jobbers drill?
5. What will happen if the point of a drill is ground off center?

Answers

1. There are many ways to drill holes when using a lathe.
   a. Clamp the workpiece to the machine spindle using an approved holding device, (chuck, collett, face plate, etc). Mount the drill in the tail stock. Turn on the machine and advance the drill into the workpiece using the hand wheel on the tail stock spindle.
   b. Same as above except you mount the drill bit on the tool post and carefully align it on center and parallel to the axis of the machine. You may then use the power feed of the machine to push the drill bit.
   c. Clamp the drill bit in the main spindle. Mount the workpiece on the compound rest and carefully align each centerpunched hole location. Again, you may use the machine feed to push the drill through the work.

2. The center drill is an extremely useful tool. It serves many purposes, some of which are listed below:
   a. Produce a clean starting hole for a larger drill to follow.
   b. Produce a proper 60 deg. countersunk hole with a small pilot hole for clearance to provide a proper seat for a lathe center.
   c. May be used to cut a 30 deg. chamfer on any shoulder when mounted properly on the lathe.

There are others. These are simply suggestions to start.

Evaluation Continued

3. A taper shank drill is a drill bit with a shank cut to a standard morse locking taper. The tail stock of any lathe is usually equipped with a tapered hole to accept these special drills. The tapered shank is far stronger than any other kind of shank, and the locking taper provides excellent support for a larger diameter drill.
   A sleeve is an enlarging or reducing device used with tapered shank tools to allow any size tool to fit any size machine.
   A drift key is a tool used to separate a taper shank tool from its mounting place or to remove a sleeve from a tapered shank tool.

4. There is no real difference except that the S&D/Gorton drills are supplied in sizes usually larger than 1/2 in. The shank is usually 1/2 in. and precision ground so that the tool may be held in a collett.

5. An off center drill point will cause any drill to cut oversize.

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 167

TASK: Center-drill hole with lathe.

CONDITIONS: A workpiece which is to be held between centers in a lathe for turning operations, specifications, lubricant and the following tools and equipment:

Combination drill and counter sink
Cutting tool bits (sharpened)
Dial indicator
Drill chuck/center drill holder
Engine lathe with attachments and accessories
Lathe manual
Machinery's handbook
Personal safety equipment
Tool post and holder.

STANDARD: When completed, the size and location of the holes will have been drilled to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 99-101.

PERFORMANCE GUIDE

1. Identify workpiece material for selection of cutting speeds and feed.
2. Secure workpiece in lathe chuck.
3. Face one end of workpiece.
4. Select/mount drill chuck and combination drill/countersink in tailstock.
5. Select and set cutting speed of spindle.
6. Start lathe.
7. Drill/countersink hole to specifications.
8. Stop lathe.
9. Reverse workpiece in chuck.
10. Start lathe.
11. Face second end to length.
12. Drill/countersink second hole to specifications.
13. Stop lathe.
14. Remove workpiece. Recheck to specifications.
15. Remove drill chuck and drill from tailstock.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Grind lathe cutting tools.

Enabling Objectives Continued

Use measuring tools.
Use holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Interpret vocabulary words.

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setups, pp. 151-255. 368-410.
2. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework).
3. View a movie on lathe operations (common operations on engine lathes).
4. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
5. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
6. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
7. Practice mounting various work holding devices on the machines in the shop.
8. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
9. Participate in a demonstration of set up procedures for aligning holes to be drilled in a lathe, given by the instructor.
10. Attend a demonstration and lecture on drilling operations.
11. Participate in a class discussion and demonstration on drilling and reaming in a lathe. (Reference material, textbook and handout).
12. Practice drilling and reaming in a lathe with instructor assistance.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50. 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments."** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting tools, Setups and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines."** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision."** pp. 9-49.

PERFORMANCE OBJECTIVE V-TECS 167

Resources Continued

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.
Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**
Ronan, William. Home and Shop Safety Series: **"Personal Safety", "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. Why should one start any drilled hole with a center drill?
2. List some other uses for a center drill?
3. What is the advantage of a center drill over a conventional drill?

Answers

1. A hole started with a center drill will most likely be in its correct location, if the center drill was properly aligned prior to drilling. The center drill provides an accurate lead hole and an accurate, smooth, chamfered surface for the standard drill bit to center itself on as it starts to drill.

2. The center drill has several uses, some of which are as follows:
   a. Produce an accurate starting hole for drilling.
   b. Produce an accurate and properly shaped center hole for a lathe center.
   c. Produce a 60 deg. chamfer on the finished edge of a hole or bore.

3. The center drill has no long drill bit length. It is designed to drill only a short distance, usually no more than 3/16 in. The remainder of the point on a center drill is ground to an accurate 60 deg. angle, out to the shank diameter of the bit. The point on a center drill is ground to cut smoothly and accurately. The combination of these features allows the center drill to accurately drill a starting hole in a precisely set location because there is no length to bend or slip on the workpiece and the specially ground point will not slip off location.

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 168

TASK: Face workpiece held in chuck on lathe.

CONDITIONS: A workpiece with a face to be surfaced, specifications and the following tools and equipment:

Dial indicator
Engine lathe with attachments and accessories
Four-jaw independent chuck
Lathe manual
Oil can w/oil
Personal safety equipment
Shims
Square
Square cutting tool bits
Three-jaw universal chuck.

STANDARD: When completed, the face of the workpiece will be smooth, true and square axis of work in accordance with specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 182-183, 209-210.

PERFORMANCE GUIDE

1. Identify workpiece material for selection of cutting speeds and feed.
2. Clean and lightly oil threads on lathe spindle. NOTE: Some lathes have cam-lock type spindle.
3. Clean threads (or cam-stud) in chuck.
4. Mount chuck on lathe spindle.
5. Mount workpiece in chuck.
    a. Three-Jaw Universal Chuck. Check and adjust for true running with shims as necessary.
    b. Four-Jaw Independent Chuck. Adjust for true running by using dial indicator.
6. Mount cutting tool bit in tool holder. Adjust as necessary.
7. Adjust cutting tool bit to center of workpiece.
8. Lock carriage to bed.
9. Select and set speed and feed.
    a. Small pieces. Hand feed.
    b. Large pieces. Use power cross-feed.
10. Face material to specifications.
11. Shut off lathe.
12. Remove workpiece.

PERFORMANCE OBJECTIVE V-TECS 168

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Grind lathe cutting tools.
Use measuring tools.
Use holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setup, pp. 151-255, 368-410.
2. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework).
3. View a movie on lathe operations (common operations on engine lathes).
4. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
5. Participate in a class discussion and demonstration on grinding lathe cutting tools. (Reference material, textbook and handout).
6. Practice grinding lathe cutting tools with instructor assistance.
7. Attend a demonstration showing each of the common methods for holding workpieces in an engine lathe. (3 jaw chuck, 4 jaw chuck, collett, between centers, face plate, etc.)
8. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
9. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
10. Practice mounting various work holding devices on the machines in the shop.
11. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
12. Participate in a demonstration of set up procedures for facing operations, given by the instructor.
13. Practice setting up parts and facing ends and shoulders. Note how the tool geometry differs from a conventional turning tool.
14. Face various work pieces to length. Finished product must conform to print specifications.

PERFORMANCE OBJECTIVE V-TECS 168

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments."** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting tools, Setups and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. What is "facing" a workpiece?
2. How is a facing tool different from a turning tool?
3. Why is facing important? How can it affect the fit of precision machined parts?
4. Can a standard turning tool also be used for facing? Explain your answer.

Answers

1. Facing is a turning procedure in which the tool makes a cut across the end or shoulder of a piece, making that surface perpendicular to, and square with, the axis of the workpiece measured lengthwise through the centerline. In simpler terms, cutting the end or a shoulder of the workpiece square with the diameter of the work.

2. A facing tool differs from a turning tool only in terms of which edge of the tool does the cutting. Properly ground, a standard turning tool can do double duty as a turning tool and a facing tool.

3. Facing is a very important procedure and should be performed as soon as possible, so that one has a smooth, flat, square, surface to make measurement. If a surface is not faced square with the axis of the workpiece, the work cannot be accurately measured for length or depth of shoulders. An unfaced surface may cause precision parts to mate improperly and cause uneven wear, unnecessary stress on the material, and may cause the piece to be scrapped.

Evaluation Continued

4. See the answer to question #2. Properly ground turning/facing is one which has a cutting angle around on both the left side cutting edge and the front side relief. A tool ground in this manner will operate as a turning tool cutting in the conventional manner, and as a facing tool, cutting on the end face of the tool.

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 169

TASK: Turn contour/angular/radii cuts with lathe.

CONDITIONS: A workpiece, specifications and the following tools and equipment:

Cutting tools (sharpened)
Engine lathe with accessories and attachments
Gages (radius, fillet)
Hermaphrodite caliper
Lathe manual
Micrometer caliper
Personal safety equipment
Steel rule
Vernier bevel protractor.

STANDARD: When completed, the lengths must be ±1/64", angles ±15' and radii in accordance with specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 220-235.

PERFORMANCE GUIDE

1. Identify workpiece material for selection of cutting tools/speeds/feeds.
2. Analyze approach/method/attachments/sequence of operations/set-ups/reference surfaces.
3. Secure workpiece in lathe.
4. Determine cutting operation(s).
5. Select/set speed.
6. Select/mount cutting tool.
7. Lay out if necessary.
8. Perform cutting operation to specification.
9. Repeat steps #3 through #8 as needed.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Use grind lathe cutting tools.
Use measuring tools.
Use holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Indentify vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 169

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setups, pp. 255, 368-410.
2. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework).
3. View a movie on lathe operations (Common operations on engine lathes).
4. Attend a lecture presentation in question and answer period at end of presentation.
5. Participate in a class discussion and demonstration on grinding lathe cutting tools. (Reference material, text book and handout).
6. Practice grinding lathe cutting tools with instructor assistance.
7. Attend a demonstration showing each of the common methods for holding workpieces in an engine lathe. (3 jaw chuck, 4 jaw chuck, collett, between centers, face plate, etc.)
8. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
9. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
10. Practice mounting various work holding devices on the machines in the shop.
11. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
12. Participate in a demonstration of set up procedures for turning radii, fillets, angles, and other shapes (contours) which can be cut using a lathe.
13. Observe a demonstration, given by the instructor, on methods and techniques to be used when performing the more complicated turning operations of cutting fillets, radii, angles, and unusual contours.
14. Practice the special turning techniques. Practice using some of the special tools involved.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines,"** Units 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, p. 38-47. Section 3, **"Measurement and Inspection,"** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments,"** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting tools, Setups and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Resources Continued

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**
Ronan, William. Home and Shop Safety Series: **"Personal Safety." "Power Tool Safety."**
Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. What is a "form" tool?
2. Explain the uses of the taper attachment.
3. Describe a method for turning a special contour on a work piece.
4. What is a "tracer lathe?" What is a tracer (profiler) attachment?
5. List several (more than 2) methods which can be used to cut a shape or profile on a workpiece in a lathe.

Answers

1. A "form" tool is a special type of lathe tool which has the shape to be created (machined) on the workpiece, ground on its cutting edge. Most "form" tools are plunged into the workpiece to create the desired shape. The tool is accurately positioned and slowly pushed into the surface to be shaped. The procedure continues until the exact size and proper shape are obtained.

2. The taper attachment on a lathe is one of several ways to produce an angular cut with relation to the axis of the workpiece. A taper attachment, when installed in its operating position, controls the movement of the cross slide on a lathe, independent of the handwheel adjustment. The taper attachment is calibrated, usually in two different scales. One is taper/ft., the notation that most industrial tapers are given in, and degrees. The taper attachment is used when turning long (over 3") tapers, where the length exceeds the travel of the compound rest.

3. There are several ways to machine a special shape on a workpiece in a lathe. The easiest is to have a form tool made and simply plunge cut the shape. This is fine for shapes no more than 1" wide. For anything over this width another method must be found. The most common is to cut the shape on a special type of lathe called a profile (or tracer) lathe. These machines are designed with the cross slide attached to a hydrauulic follower device which follows a template (a precision made guide containing the mirror image of the part to be manufactured). As the tool is moved along the diameter of the workpiece, a follower on the template controls the depth of cut, producing the desired contour on the workpiece. In todays modern shops, the place of the template has been taken by a computer. Now the computer controls the position of the cross slide as the cut is made, thus producing the desired contour. This is an over simplification of the methods, however, these are tried and proven methods, and in a small shop, may well be the only way possible with the available equipment.

Evaluation Continued

4. A tracer lathe is a machine with a cross slide which can be controlled by a follower on a template. The follower device may be operated by hydraulics, air, or computer. The ideal is that the follower rides along the edge of a precision made mirror copy of the shape to be created. As the follower moves along it controls the depth of the cutting tool moving along the workpiece. Any change in the position of the follower in relation to the centerline of the work, will be accurately duplicated by the cutting edge of the tool, thus creating an exact duplicate of the shape on the template.

5. A list of ways to produce a desired contour on a workpiece might be as follows.
    a. Have the desired shape ground on a form tool and plunge cut the profile.
    b. If available, mount a template on a tracer lathe and cut the profile.
    c. If available, mount a template on the lathe and, using an indicator for a follower, carefully contour the workpiece by hand.
    d. Use a portable tracer attachment (Tymac or other commercial device).
    e. Use a CNC or NC lathe to cut the profile after writing an appropriate program.

There may be other methods. These are suggestions and are not to be considered the only possible answers.

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 170

TASK: Ream hole with lathe.

CONDITIONS: A workpiece with drilled hole(s) requiring reaming, specifications and the following tools and equipment:

Chuck
Engine lathe with attachments and accessories
Lathe manual
Machinery's handbook
Personal safety equipment
Plug gages
Reamer holder (drillchuck or tapered tailstock spindle).

STANDARD: When completed, holes will be smooth, free of chatter marks and in accordance with specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 77-80, 214.

PERFORMANCE GUIDE

1. Identify workpiece material for selection of cutting speeds/feed.
2. Chuck workpiece in lathe.
3. Mount reamer in chuck or floating reamer holder in tailstock.
4. Select/set spindle speed and turn on lathe.
5. Ream to specifications by operating tailstock/handwheel. Lubricate as needed.
6. Check measurements with plug gage.
7. Stop lathe.
8. Remove workpiece.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Use grind lathe cutting tools.
Use measuring tools.
Use holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 170

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setups, pp. 151-255, 368-410.
2. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework).
3. View a movie on lathe operations (Common operations on engine lathes).
4. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
5. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
6. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
7. Practice mounting various work holding devices on the machines in the shop.
8. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
9. Participate in a demonstration of set up procedures for aligning holes to be reamed in a lathe, given by the instructor.
10. Attend a demonstration and lecture on reaming operations.
11. Participate in a class discussion and demonstration on reaming in a lathe. (Reference material, textbook and handout).
12. Practice reaming on a lathe with instructor assistance.
13. Attend a demonstration showing how to align a predrilled hole for reaming in an engine lathe.
14. Practice setting up parts with holes to be reamed. Note the use of the tail stock center and an indicator.
15. Ream holes to specified sizes using proper tools. Finished holes must be accurately located and machined to print specifications as to finish and size.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34,35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments,"** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting tools, Setups and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Resources Continued

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. What is the difference between drilling and reaming?
2. Which method is more accurate for sizing holes, drilling or reaming? Explain your answer.
3. What happens if you leave too much material in a hole to be reamed out?
4. List 4 different types of reamers and describe the use of each.
5. Reaming is as good as honing for producing smooth, straight holes. Explain why you agree or disagree with this statement.

Answers

1. Drilling is the process of cutting a roundhole into or through a workpiece.
   Reaming is a process of accurately sizing an already existing hole.

2. Reaming: Drilling produces a hole which may or may not be accurate for size. To produce truly accurate sized holes, they should be reamed. Reamers are accurately ground on their periphery. They cut on this outside surface rather than on the end like a drill. A reamer requires lots of coolant/lubricant because of the large cutting area of the flutes. Because reamers cut on their diameter, not on the bottom they can be ground to exact sizes. They also have many cutting edges, not just two like a drill.

3. Reamers are classified into many different types. Some can remove relatively large amounts of stock, while others work better only removing a small amount of material. A hole with too much material for the reamer selected to remove will probably come out oversized. The reamer has little clearance between its cutting edges so space for chips to gather is limited. Once the chips pack up in the reamer they might cause the reamer to cut big, or worse, cause the reamer to bind and maybe break. A good rule to follow is to leave no more than .010 in a hole to be reamed.

4. Rose reamer: Has fewer teeth than the machine reamer and cuts on the leading edge of the teeth. Used for removing heavier amounts of stock.
   Fluted machine reamer: Has many flutes (cutting edges) and is ground to cut primarily on the sides rather than on the end like a rose reamer. Because of the many teeth, only small amounts of material should be cut with this type of reamer.

Evaluation Continued

Hand reamer: As its name implies, this type of reamer is used by hand, used when extremely accurate fitted holes are needed. They require much skill on the part of the mechanic. They remove the least amount of stock.
Expansion reamers: These are a special type which can be adjusted to any size within the limits of their range. They are used to produce accurate holes where nothing is standard sized.

5. Disagree: Reaming can produce smooth straight holes. This is true but only within the availability of cutter size and operator skill at using reamers. Reamers are primarily a cutting tool. A hone is more a polishing tool since it removes such a small amount of stock. Hones are designed to produce highly polished, straight, smooth holes. Accuracy is also much more critical.

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 171

TASK: Rechase threads on lathe.

CONDITIONS: A workpiece with rough threads, thread specifications, lubricant and the following tools and equipment:

Engine lathe with attachments and accessories
Gages (thread center, ring, plug)
Personal safety equipment
Single point tools (ground to proper thread form).

STANDARD: When completed, threads will be smooth and in accordance with specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 286-293.

PERFORMANCE GUIDE

1. Identify workpiece material for selection of cutting speeds and feed.
2. Place workpiece in chuck or between centers.
3. Select/mount cutting tool.
4. Align cutting tool with thread.
5. Select and set cutting speed of spindle.
6. Select and set rate of feed of carriage.
7. Make thread-chasing dial selection.
8. Turn on lathe.
9. Trial run tool before cutting as necessary.
10. Rechase threads to specifications. Lubricate as necessary.
11. Shut off lathe.
12. Check to specifications with thread gage.
13. Remove workpiece.
14. Remove cutting tool.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Use lathe grind cutting tools.
Use measuring tools.
Use lathe holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

PERFORMANCE OBJECTIVE V-TECS 171

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setups, pp. 151-255, 368-410.
2. Read chapters on threads and threading. Write answers to questions at end of chapter.
3. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework).
4. View a movie on lathe operations (Common operations on engine lathes).
5. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
6. Participate in a class discussion and demonstration on grinding lathe cutting tools. (Reference material, text book and handout).
7. Practice grinding lathe cutting tools with instructor assistance.
8. Attend a demonstration showing each of the common methods for holding workpieces in an engine lathe. (3 jaw chuck, 4 jaw chuck, collett, between centers, face plate, etc.)
9. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
10. View a demonstration given by the instructor on how to remove and replace various work holding devices on lathes in the shop.
11. Practice mounting various work holding devices on the machines in the shop.
12. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
13. Participate in a demonstration on a lathe, given by the instructor.
14. Practice setting up parts to be threaded. Note: Be sure to use the center gage to set the threading tool. Note: Be sure to turn compound to 29.5 deg. before going too far with basic set up.
15. Observe demonstration of techniques for chasing threads on a lathe. (chasing threads = cutting threads on a lathe with a single point cutting tool).
16. Observe a demonstration of the techniques used for picking up an existing thread and performing a rechasing operation.
17. Practice chasing external threads of various pitches.
18. Practice chasing internal threads of various pitches.
19. Practice chasing left handed threads of various pitches, both inside and outside.
20. Practice picking up a thread for the rechasing operation.
21. Practice rechasing various threads both inside and outside.

PERFORMANCE OBJECTIVE V-TECS 171

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Unit 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129. Section 4, **"Hand Tools and Benchwork."** Units 27, 28, pp. 185-200.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments,"** pp. 151-179. Chapter 7 **"Engine Lathe: Cutting Tools, Setups and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49. Chapter 3, **"Bench Tools." "Hand Taps and Tapping,"** pp. 64-71.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 41-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Ronan, William. "Home and Shop Safety Series": **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. What is a center gauge? Why is it so important when threading?
2. What is pitch? What is a pitch gage?
3. Describe how a thread is "picked up."
4. What is the advantage of turning the compound to 29 to 29.5 degrees instead of plunging straight into the work?
5. Why should the half nut not be disengaged after the thread is successfully picked up?

Answers

1. A center gauge is a tool used for several purposes.
    a. It is used to set a threading tool perpendicular to the center line of the workpiece. (At 90 deg. to the center line).
    b. It is used as a gauge for grinding the proper shape point on a tool used for threading.

2. Most simply stated, pitch is the distance from the top of one thread to the same point at the top of the next thread. Another way to state it is the distance between two adjacent threads.
   Lead is the distance that a point on one thread moves as the screw is rotated one full turn.
   Actually, these two terms describe the exact same thing and they are interchangeable as long as you are talking about single lead threads. They will differ when talking about multiple lead threads.

Evaluation Continued

These terms can be expressed in a formula as follow:
Pitch = 1 in./threads per inch
lead = 1 in./threads per inch
(unless the thread is a multiple lead thread) then
lead = 2 (double)
3 (triple) x (1 in./threads per inch)
4 (quad)

3. A thread may be "picked up" in a number of ways. One method could be as follows:

   a. Mount the piece in any convenient manner. Be sure that the piece is running as true as possible.
   b. Mount a threading tool in the tool post. Remember to turn the tool compound rest to 29° to 29.5 degrees. Align the tool using a center gauge.
   c. Use a pitch gauge to determine the number of threads to the inch and a micrometer to determine the diameter (if it is an external thread).
   d. Start up the lathe and engage the half nut. Using a lens for magnification, adjust the location of the tool so that the right hand flank of the tool is just scraping the left flank of the thread to be picked up.
   e. Use the handwheel on the compound rest to move the point of the tool to the bottom of the thread.
   f. Stop the lathe, when the depth is reached, and carefully adjust the zero setting on the handwheel for the cross slide. From this point on, MOVE ONLY THE CROSS SLIDE. DO NOT DISENGAGE THE HALF NUT OR MOVE THE COMPOUND REST HANDWHEEL.
   g. Use a jump out technique at the end of the thread and reverse the machine to back up to make your next cut.
   h. Proceed as if chasing a conventional thread except that any depth adjustment of the tool is performed with the cross slide, not the compound rest.

4. The advantage gained when turning the compound to an angle of 29.5 degrees is ease in producing clean, properly shaped threads. As the properly ground threading tool is advanced into the work along this 29.5 degree angle only one side of the tool does the heavy cutting. The difference of one degree allows the trailing flank of the tool to shave that side of the thread, producing clean smooth surfaces. When you plunge straight into the work, equal size cuts are made with both sides of the tool. This results in very heavy pressure on the cutting tool point and will not produce the clean smooth surfaces necessary for maximum strength.

Evaluation Continued

5. Never disengage the half nut after you have successfully picked up a thread to be rechased. Usually, the place where you finally get the tool to track properly will not be at a calibrated location on the threading dial. The only way to be sure of keeping this critical location is to leave the half nut engaged. Of course, you will have to reverse the machine after you jump out to go back to the end of the workpiece before making another cut.

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 172

TASK: Tap thread with lathe.

CONDITIONS: A workpiece, specifications for tapped hole, lubricant and the following tools and equipment:

Drill with chuck
Engine lathe with attachments and accessories
Lathe manual
Machinery's handbook
Personal safety equipment
Taps
Thread gages
Thread tapping attachment and/or floating holder.

STANDARD: When completed, the thread will be smooth and tapped to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 80-83.

PERFORMANCE GUIDE

1. Identify material of workpiece for selection of tap and cutting speed.
2. Mount workpiece in chuck.
3. Face and square workpiece.
4. Center drill hole.
5. Chamfer hole.
6. Select/mount tap drill.
7. Drill hole.
8. Select/mount tap holder in tailstock.
9. Select/mount tap in holder.
10. Unclamp tailstock and align tap to hole.
11. Select/set spindle speed at slow RPM.
12. Turn on lathe.
13. Tap hole to specifications. NOTE: Maintain pressure on tailstock so tap does not pull out. Lubricate as necessary. Stop and reverse spindle as necessary to clear work of cuttings and retract tap.
14. Remove burrs.
15. Stop lathe.
16. Remove workpiece.
17. Remove tap/holder.

PERFORMANCE OBJECTIVE V-TECS 172

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Use grind lathe cutting tools.
Use measuring tools.
Use lathe holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setups, pp. 151-255, 368-410.
2. Read chapters on threads and threading. Write answers to questions at end of chapter.
3. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework).
4. View a movie on lathe operations (common operations on engine lathes).
5. Attend a lecture presentation in question and answer period at end of presentation.
6. Participate in a class discussion and demonstration on grinding lathe cutting tools. (Reference material, textbook and handout).
7. Practice grinding lathe cutting tools with instructor assistance.
8. Attend a demonstration showing each of the common methods for holding workpieces in an engine lathe. (3 jaw chuck, 4 jaw chuck, collett, between centers, face plate, etc.)
9. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
10. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
11. Practice mounting various work holding devices on the machines in the shop.
12. Practice mounting workpieces, in each of the holding devices discussed. Note the differences as well as the similarities in each.
13. Participate in a demonstration of tapping methods to be used when cutting threads by this method on a lathe.
14. Practice setting up parts to be tapped.
15. Practice tapping threads with a lathe.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 22-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129. Section 4, **"Hand Tools and Benchwork."** Units 27, 28, pp. 185-200.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments,"** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting Tools, Setups and Operations."** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49. Chapter 3, **"Bench Tools." "Hand taps and Tapping,"** pp. 64-71.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. Describe the commonly used procedure by hand on a lathe or other machine to perform tapping in a lathe.
2. Describe the commonly used procedure by machine to perform tapping.

Answers

1. a. General process for both procedures:

    1. Carefully lay out the hole location(s) on the workpiece, center punch and scribe a reference circle at each location.
    2. Set up in the lathe, align center punch with center, clamp workpiece.
    3. Refer to tapping charts and select the proper tap drill. (A drill selected to leave sufficient material in the hole to produce a 75 percent or greater full thread).
    4. Spot with center drill and check to assure proper alignment.
    5. Mount the tap drill and drill the hole to proper depth or through as required.

   b. By hand, on the lathe or other machine:

    1. After drilling the proper sized tap drilled hole do NOT remove the workpiece from the machine. Leave the clamps in place.

Evaluation Continued

2. Remove the drill from the chuck and insert a tool called a tapping center. (A ground pointed tool used to support the end of the tap while it is turned by the mechanic. It may be a solid piece or it may be spring loaded or both).
3. Engage the point of the center either with the tap or the "T" handled tap wrench, for support.
4. Keeping pressure on the center, slowly turn the tap into the piece 1/2 turn. Release pressure and back off slightly to break the chip. Continue this procedure until tap cuts through the piece or until proper depth is reached. Remember the tap may have to be removed several times to remove chips from a blind hole.
5. Move on to next hole and repeat entire operation from step 1a.
6. Remove from the machine, deburr and clean all chips, grease and oil to complete.

2. a. After drilling the proper size holes remove the drill and drill chuck.
   b. Do not move your workpiece or remove any clamp.
   c. In place of the drill chuck install a device called a tap driver. This is a special tool designed to drive a tap into a workpiece. This is simply a chuck designed to hold a tap.
   d. Mount your tap in whatever device you are going to use to drive the tap.
   e. SLOW down the spindle speed and start the spindle.
   f. Press the tap into the hole firmly, using the quill on the machine. Keep the pressure on until tap cuts through the pieces. If you are tapping a blind hole, set a stop or other device so that you know when to release pressure or stop the machine.
   g. Reverse the machine and back the tap out. Clear all chips and check for proper fit and depth.
   h. Move on to next hole and repeat from step 1a.
   i. Remove from the machine, deburr and clean all grease and oil to complete.

NOTE: It is not recommended that tapping by machine be attempted in blind holes without the proper type of tap driver and proper training and experience given to the machine operator. (Taps break easily and are expensive).

DUTY: PERFORMING TURNING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 173

TASK: Cut short external taper on lathe using compound rest.

CONDITIONS: A workpiece, specifications for taper and the following tools and equipment:

Cutting tool
Dial indicator
Drill chuck
Drills
Engine lathe with attachments and accessories
Lathe manual
Machinery's handbook
Micrometer
Personal safety equipment
Taper gage
Vernier bevel protractor.

STANDARD: When completed, the taper surface must be smooth, free of chatter marks, and cut according to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 220-235.

PERFORMANCE GUIDE

1. Identify material of workpiece for selection of cutting speeds and feed.
2. Chuck workpiece on lathe.
3. Select and set speed for facing.
4. Face workpiece and center drill.
5. Reverse ends of workpiece face to length and center drill.
6. Mount workpiece between centers.
7. Set compound rest to specifications with dial indicator and vernier bevel protractor.
8. Mount, adjust and secure cutting tool.
9. Make rough cut.
10. Measure workpiece and adjust cutting tool and compound rest as necessary.
11. Select and set spindle speed for finish cuts.
12. Finish cut to specifications.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Use grind lathe safety tools.

Enabling Objectives Continued

Use measuring tools.
Use holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter Machine Shop Operations and Setups, pp. 151-255, 368-410.
2. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework).
3. View a movie on lathe operations (common operations on engine lathes).
4. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
5. Participate in a class discussion and demonstration on grinding lathe cutting tools. (Reference material, textbook and handout).
6. Practice grinding lathe cutting tools with instructor assistance.
7. Attend a demonstration showing each of the common methods for holding workpieces in an engine lathe. (3 jaw chuck, 4 jaw chuck, collett, between centers, face plate, etc.)
8. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
9. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
10. Practice mounting various work holding device on the machines in the shop.
11. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
12. Observe a demonstration of set up procedures for turning tapers on a lathe using the compound rest, given by the instructor.
13. Practice setting up and turning various tapers on parts in a lathe. Note the use of the calibrated scale on the base of the compound rest.
14. Observe a demonstration by the instructor showing how to cut a taper by offsetting the tail stock support. NOTE: Classroom lecture should include a discussion of how to calculate the amount of offset for given taper angle.
15. Discuss other methods for cutting tapers on the inside and outside of various workpieces.
16. Turn a taper to specified sizes using proper tools. Finished taper must be accurately located and machined to print specifications as to finish, size, and location.

PERFORMANCE OBJECTIVE V-TECS 173

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 3, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments."** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting Tools, Setups and Operations,"** pp. 180-255. Chapter 7, **"Engine Lathes: Cutting Tools, Setups and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines."** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision."** pp. 9-49.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Ronan, William. Home and Shop Safety Series: **"Personal Safety," "Power Tool Safety."**

Starrett. Tools and Rules for Precision Measuring, pamphlet, pp. 13-15, 17-23, 56-58.

EVALUATION

Questions

1. What is the compound rest?
2. What is the taper attachment? Describe how it works.
3. List at least three different ways for cutting accurate tapers/angles with lathe.

Answers

1. The compound rest on a lathe is the adjustable block on which the tool post is mounted. It has a lead screw of its own and can be turned to any angle with reference to the axis of the machine. Using the lead screw handwheel, the cutting tool can be moved along a line parallel to the angle at which the compound is set.

2. The taper attachment for a lathe is a device which provides an easy way to turn long tapers. One way a taper attachment might work is as follows:

   The taper attachment is set for the angle to be turned and securely clamped in place. The follower on the attachment is then attached to the cross slide and the cross slide lead screw is disconnected so that the taper attachment will control the in and out motion of the cross slide. The in and out adjustment of the cutting tool is controlled by the handwheel on the compound rest, which should be set perpendicular to the axis of the machine. When the carriage is moved, the follower on the taper attachment slides along at the preset angle. This in turn moves the cross slide into or away from the workpiece producing the desired angular cut.

Evaluation Continued

3. Some ways to cut a taper might be as follows:
   - a. Taper attachment
   - b. Compound rest
   - c. Set broad nosed tool to the desired angle and plunge cut.
   - d. Offset the tail stock.

PERFORMANCE OBJECTIVE V-TECS 174

TASK: Cut off workpiece held in chuck with parting tool.

CONDITIONS: Metal stock, specifications for finished workpiece(s) and the following tools and equipment:

Cut-off or parting tool bit and cut-off blade holder
Cutting Lubricant
Cutting tool bit
Engine lathe with attachments and accessories
File
Lathe manual
Machinery's handbook
Micrometer
Personal safety equipment
Scale
Tool holder.

STANDARD: When completed, the surfaces of the finished workpiece(s) will be smooth, free of chatter marks and burrs, and cut to specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Moltrecht. **Machine Shop Practice.** Vol. 1, pp. 217-219.

PERFORMANCE GUIDE

1. Identify the metal stock for selection of cutting speed and feed.
2. Mount stock in chuck.
3. Face and square stock.
4. Mount and secure cut-off tool bit.
5. Select and set cutting speed for spindle.
6. Select and set feed rate on power cross-feed.
7. Make light parting cut and check length.
8. Cut workpieces to specifications use, cutting lubricant as needed. Deburr as necessary.
9. Check measurements to specifications.
10. Remove stock.

ENABLING OBJECTIVES

Use personal safety rules.
Use lathes safety rules.
Use grind lathe cutting tools.
Use measuring tools.
Use holding devices.
Use charts and tables for cutting speeds, feeds, and threads.
Read a blueprint.
Identify vocabulary words.

LEARNING ACTIVITIES

1. Read chapter on engine lathe operations. Write answers to questions at end of chapter - Machine Shop Operations and Setups, pp. 151-255, 368-410.
2. Participate in classroom discussion on lathe operations. (Reference material - student handout and written homework).
3. View a movie on lathe operations (Common operations on engine lathes).
4. Attend a lecture presentation on special cutting methods and techniques. Participate in question and answer period at end of presentation.
5. Participate in a class discussion and demonstration on grinding lathe cutting tools. (Reference material, textbook and handout).
6. Practice grinding lathe cutting tools with instructor assistance.
7. Attend a demonstration showing each of the common methods for holding workpieces in an engine lathe. (3 jaw chuck, 4 jaw chuck, collett, between centers, face plate, etc.)
8. Study chapter in textbook showing the removal and installation of work holding devices on engine lathes - General Industrial Machine Shop, pp. 222-316.
9. View a demonstration given by the instructor on how to remove and replace various work holding devices on the lathes in the shop.
10. Practice mounting various work holding devices on the machines in the shop.
11. Practice mounting workpieces in each of the holding devices discussed. Note the differences as well as the similarities in each.
12. Participate in a demonstration of set up procedures for cut off operations on a lathe, given by the instructor.
13. Practice setting up parts to be cut off.
14. Cut off parts to specified sizes using proper tools. Finished parts must be accurately cut to print specifications as to finish and size.

RESOURCES

Johnson. **"General Industrial Machine Shop."** Section 5, **"Machining Metal with Turning Machines."** Units 33, 34, 35,36, 37, 38, 39, 40, 41,42, 43, 44, 45, 46,47, 48, 49, 50, 51, 52, 53, pp. 222-316. Section 1, **"Introduction to Machine Shop Practices."** Unit 6, pp. 38-47. Section 1, **"Measurement and Inspection."** Units 13, 14, 15, 16, 17, pp. 83-129.

Lasco, et al. **"Machine Shop Operations and Setups."** Chapter 6, **"Engine Lathes: Types, Accessories and Attachments,"** pp. 151-179. Chapter 7, **"Engine Lathes: Cutting Tools, Setups and Operations,"** pp. 180-255. Chapter 11, **"Production Turning: Turret Lathes and Automatic Screw Machines,"** pp. 368-410. Chapter 2, **"Measuring Tools: Semi-Precision and Precision,"** pp. 9-49.

Olivo, et al. **"Basic Blueprint Reading and Sketching."** Section 3, **"Dimensions and Notes,"** pp. 42-63.

Rockwell Intl. **"Nomenclature Chart with Safety Suggestions."**

Starrett. Tools and Rules for Precision Measuring, pamphlet. pp. 13-15, 17-23, 56-58.

PERFORMANCE OBJECTIVE V-TECS 174

EVALUATION

Questions

1. How does a cut off tool differ from a standard lathe turning tool?
2. A cut off tool cannot be used for any other lathe operation. (T) (F) Explain your answer.
3. What is the most important clearance which should be ground on a cut off tool?
4. Cut off should be performed at a slower speed than turning. Why?
5. Can proper shaping of the cutting edge of a cut off tool be of any special significance?

Answers

1. A cut off tool is quite different from a conventional turning tool in many ways. The most obvious is its basic shape. Cut off tools are generally quite thin, seldom exceeding 3/16 in. in width. The most common size is 1/8 in. wide. The tool is usually held in a special holder designed for the thin, flat blade. Sometimes, a cut off tool may be ground on a conventional tool bit for special application or if no other cut off tool is available. Cut off tools have maximum side clearance to allow free cutting through a great depth.

2. (F) A cut off tool may be used for cutting grooves in the outside diameters of lathe workpieces. It may also be used for certain special turning operations. The important thing is that the narrow width of the tool is useful for many applications requiring a narrow tool.

3. Side clearance and relief angles are the two most important features of a cut off tool. Side clearance will prevent the flank of the tool from dragging on the face of the work as the blade passes through. Relief angle is ground behind the cutting edge, again to prevent the tool from dragging as it passes through the work.

4. Because of the nature of the cutting action of the tool, cut off should be performed at a slower speed than turning. The slower speed will allow the chips formed to come out of the narrow slot smoothly and evenly. At high speeds chips simply pile up on the narrow slot and will break the blade. If you are using a broad cutting edge on your cut off blade, chatter will develop if you run too fast, again causing poor finish and a possibility of tool breakage.

5. The shape of the cutting edge of a cut off blade will determine how the tool cuts. For most applications, a flat surface parallel to the axis of the work will do the best job. On tubing or on pieces with a through hole, if you grind the point at angle to the axis of the work, when cut off is accomplished, one inside edge will be free of a burr and flat and smooth. Shaping the cutting edge to suit the job is quite useful and, in some cases, time and labor saving.

PERFORMING SHAPING AND CUTTING OPERATIONS

DUTY: PERFORMING SHAPING AND CUTTING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 175

TASK: Cut horizontal surface.

CONDITIONS: A workpiece, specifications and the following tools and equipment:

Dial indicator
Layout table
Lead hammer or mallet
Machinery's handbook
Micrometer
Personal safety equipment
Scale
Shaper and accessories
Shaper manual
Shaper vise
Square
Surface plate
Tool bits
Tools holder.

STANDARD: When completed, surface must be smooth and flat within .010".

SOURCE OF STANDARD:
Wisconsin Writing Team.

Oberg, et al. **Machinery's Handbook.** 21st ed., pp. 1539, 2389.

PERFORMANCE GUIDE

1. Identify material for selection tool bit, cutting speed and feed.
2. Secure workpiece in shaper vise.
3. Select and mount tool bit in ram head.
4. Square workpiece to ram head.
5. Select and set length of stroke.
6. Select and set speed of stroke.
7. Select and set feed rate.
8. Position tool bit to workpiece.
9. Start shaper.
10. Engage shaper stroke control.
11. Engage feed control.
12. Disengage feed control.
13. Disengage stroke control.
14. Turn shaper off.
15. Check workpiece to specifications.
16. Remove workpiece.

PERFORMANCE OBJECTIVE V-TECS 175

ENABLING OBJECTIVES

Demonstrate proficiency with precision measuring instruments.
Read and interpret handbook of machinery use hand tools.

LEARNING ACTIVITIES

1. Explain the principles of operation of the shaper.
2. List the setup procedures for horizontal and vertical shaper operations, and emphasize the importance of eye protection when using metal working machinery.
3. Demonstrate the grinding of tool bits for various operations.
4. Show a typical machine set up, and demonstrate horizontal and vertical shaping operations.
5. Engage the students in making horizontal shaper cuts and check their work for accuracy.

RESOURCES

Johnson, **Technical Metals.** Chapter 77, pp. 354-360.

Walker, **Metalworking.** Unit 37, pp. 37-1 to 37-16.

EVALUATION

Questions

1. The cutting bit on the shaper:
   - a. Is stationary and the work moves against it.
   - b. Is pushed across the work.
   - c. Moves across the work which is stationary.
2. The shaper is used to machine:
   - a. Contoured surfaces
   - b. Irregular surfaces
   - c. Flat surfaces
   - d. All of these.
3. It is most important that the work:
   - a. Be marked before machining.
   - b. Be held securely on the table.
   - c. Be of high carbon steel.
   - d. Be less than 5 inches thick.

Answers

1. b
2. d
3. b

DUTY: PERFORMING SHAPING AND CUTTING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 176

TASK: Cut metal stock with power hacksaw.

CONDITIONS: Metal stock, specifications, bluing, coolant and the following tools and equipment:

Bench vise (attached to bench)
Combination square set
Floor stand
Lead hammer or mallet
Personal safety equipment
Power hacksaw (with blade)
Scriber
Steel rule
Steel tape measure.

STANDARD: When completed, stock must be cut within 1/16" of the outside of the lay out line.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lay out stock and mark.
2. Place metal stock in saw vise. Support with floor stand as necessary.
3. Lower saw blade.
4. Adjust stock to blade for cut and lock in vise.
5. Adjust gage or stop if necessary. Lock in place.
6. Plug power hacksaw (if portable saw) into power source.
7. Turn on power hacksaw.
8. Turn on and adjust coolant nozzle as necessary.
9. Saw stock to specifications.
10. Check measurement with rule or tape.
11. Turn off power hacksaw.
12. Remove electrical cord (plug) from power source.
13. Remove metal stock from vise.

ENABLING OBJECTIVES

Demonstrate proficiency with measuring instruments.
Use handtools.

PERFORMANCE OBJECTIVE V-TECS 176

LEARNING ACTIVITIES

1. Explain the principles of operation of the power hacksaw.
2. Discuss the setup procedures for cutting operations.
3. Discuss the selection of blades for various operations.
4. Show a typical machine set up, and demonstrate several cuts on different materials.
5. Engage the students in making cuts and check the work for accuracy.

RESOURCES

Johnson. **Technical Metals.** Chapter 14, pp. 90-96.

Walker, **Metalworking.** Unit 35, pp. 35-1 to 35-6.

EVALUATION

Questions

1. The cutting blades for power hacksaws:
    a. Have two types of sets.
    b. Vary with rate and thickness of material.
    c. Move across the work which is stationary.
    d. All of the above.
2. The power hacksaw should be set up:
    a. With the blade at a low angle and the work held securely.
    b. To cut as fast as possible.
    c. The blade set at an acute angle and the work clamped.
    d. With coolant fed to the cut at all times.
3. Which of these are proper clothing for operating power hacksaws?
    a. Safety glasses
    b. Loose jewelry removed
    c. Snug fitting attire
    d. All of these.

Answers

1. d
2. a
3. d

DUTY: PERFORMING SHAPING AND CUTTING OPERATIONS

PERFORMANCE OBJECTIVE V-TECS 177

TASK: Cut metal shapes using shear.

CONDITIONS: A metal workpiece, specifications, bluing and the following tools and equipment:

Clamps
Combination square set
Metal cutting shear
Personal safety equipment
Scribe
Shear manual
Steel tape
6" scale.

STANDARD: When completed, the metal shapes must be free of burrs and sheared to within 1/64" of specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lay out stock.
2. Position workpiece on shear. Clamp or secure as necessary.
3. Turn on power control switch.
4. Shear metal stock by activating blade control switch.
5. Turn off power control switch.
6. Check measurements.
7. Remove metal.

ENABLING OBJECTIVES

Demonstrate proficiency with measuring instruments.
Use handtools.

LEARNING ACTIVITIES

1. Explain the principles of operation of the power shear.
2. Discuss the setup procedures for shearing operations.
3. Emphasize the importance of accuracy in making measurements and cuts.
4. Show typical machine setup and demonstrate several cuts on different materials.
5. Engage the students in making cuts and check the work for accuracy.

PERFORMANCE OBJECTIVE V-TECS 177

RESOURCES

Johnson. **Technical Metal.** Chapter 46, p. 182.

Walker. **Metalworking.** Unit 19, pp. 19-8.

EVALUATION

Questions

1. The blades for power shears:
   a. Have two types of sets.
   b. Vary with thickness of material.
   c. Are positioned at an angle to the table.
   d. All of the above.
2. Which of the following is not part of a power shear?
   a. Deflection barrier
   b. Foot pedal
   C. Back gauge
   d. Hold down and guard.
3. Which of these is/are proper clothing for operating power shears?
   a. Safety glasses
   b. Gloves
   c. Safety boots
   d. All of the above.

Answers

1. c
2. a
3. d

INSPECTING AND TROUBLESHOOTING EQUIPMENT

DUTY: INSPECTING AND TROUBLESHOOTING EQUIPMENT

PERFORMANCE OBJECTIVE V-TECS 178

TASK: Inspecting and troubleshooting linkages and lever mechanisms.

CONDITIONS: Machine containing linkages and lever mechanisms and the following tools and equipment:

Inventory of replacement parts
Lock
Maintenance mechanic's tool box (handtools)
Manufacturer's specifications
Personal safety equipment
Plant/shop policy/procedures for disassembly/repair/replacement/discard
Tags
Wiping rag.

STANDARD: When completed, the faulty, worn or damaged parts must be identified, repaired or replaced and the machines must operate in compliance with manufacturer's specification. Part(s) must be tagged for repair, replacement, or discard.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen. **Developing Troubleshooting Skills**, pp. 81-96.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Check plant/shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check machine/equipment manuals for authorized field assembly/disassembly and repair.
4. Inspect linkages and levers.
   a. Look for damaged, bent or broken parts.
   b. Look for stripped threaded parts pulled apart.
   c. Look for worn parts/connections, elongated holes, stripped splines.
5. Unlock/run the equipment/machine and determine cause for distorted, worn and broken parts.
6. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules. NOTE: It may be more cost-effective to get/keep machine operational and eliminate cause of breakdown later.
7. Lock out power. Replace/repair/discard the broken and/or distorted parts in accordance with manufacturer's manuals, shop practice, and supervisor's recommendations.

Performance Guide Continued

8. Unlock/run the machine and adjust linkages and levers according to manufacturer's specifications.
9. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #7.
10. Tag part(s) for repair, replacement, or discard.

ENABLING OBJECTIVES

Use of measuring tools.
Use of handtools.
Ability to read and understand service manuals.
Use knowledge of linkages and levers.
Use knowledge of safety statements.
Use knowledge of fits and alignment.

LEARNING ACTIVITIES

1. Show how to install lockout on power supply.
2. Identify worn components.
3. Identify wear points in levers and linkages.
4. Identify if worn components can be salvaged or must be replaced.
5. Explain proper procedure for checking.
6. Demonstrate how to update maintenance records to reflect repairs.
7. Evaluate when completed, using evaluation questions.

RESOURCES

Oberg, et al. **Machinery Handbook**, p. 308.

Manufacturer's Specifications.

EVALUATION

Questions

1. Explain what is meant by pin is out of round or tapered.
2. Explain what is meant by bushing bore is egg shaped.
3. Explain which of the following would effect the proper function of a lever driver:
   a. Fit of bushing in lever
   b. Fit of pin in bushing
   c. Fit of pin in lever
   d. All of above.

Evaluation Continued

4. Which of the following would you use to check roundness of a pin?
   a. 6" scale
   b. Outside collar
   c. Micrometers
   d. All of the above.
5. Explain how you would check the squareness of one pin to the other and why this is critical to its performance.

Answers

1. High and Low points
2. High and low points
3. d
4. c
5. a. Precision square and mikes
   b. Out of squareness could cause binding.

DUTY: INSPECTING AND TROUBLESHOOTING EQUIPMENT

PERFORMANCE OBJECTIVE V-TECS 179

TASK: Inspecting and troubleshoot roller/ball bearings.

CONDITIONS: Machinery with roller/ball bearing, cleaning fluid and the following tools and equipment:

Inventory of replacement parts
Lock
Maintenance mechanic's tool box (handtools)
Manufacturer's specifications
Personal safety equipment
Plant/shop/ policy/procedures on disassembly/repair/replacement/discard
Tags
Vibration detector
Wiping rags.

STANDARD: When completed, bearings not in compliance with manufacturer's operating specifications have been identified, cause of damage determined. The bearings will be tagged for repair, replacement, or discard.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Check plant/shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check equipment manuals for authorized field assembly/disassembly and repair.
4. Disassemble machine/mechanism to expose areas containing bearings as necessary.
5. Remove bearings from shafts as necessary.
6. Remove all grease and dirt from bearing.
7. Inspect the bearing for freedom of rotation.
8. Inspect the bearing for smooth operation with vibration detector.
9. Inspect for wear markings and damage.
10. Determine cause of breakdown/malfunction.
11. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules.
12. Replace/repair/discard part(s) in accordance with manufacturer's manuals, shop practice, and supervisor's recommendations.
13. Eliminate cause of breakdown/malfunction as necessary.
14. Tag the bearings for repair/replacement/discard.

PERFORMANCE OBJECTIVE V-TECS 179

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of mechanic's stereoscope.
Use knowledge of bearings.
Use knowledge of safety standards.

LEARNING ACTIVITIES

1. Show how to install lockout of power supply.
2. Explain how to use a stereoscope to check antifriction bearings for wear or damage.
3. Explain proper procedure for removal and installation of bearings.
4. Explain proper procedure for cleaning and lubrication of bearings.
5. Demonstrate how to update maintenance service records.
6. Evaluate when complete, using evaluation questions.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Explain installing bearings using heat transfer.
2. Which could cause bearing failure?
    a. Dirt
    b. Improper lubrication
    c. Misalignment
    d. All of the above.
3. Which statement is true?
    a. Taper roller bearings will take thrust load only.
    b. Angular contact bearings will take thrust and radial load.
    c. Thrust bearing will handle radial load.
4. Check the following items that will effect the life and performance of friction bearings:
    a. Roundness of shaft or housing
    b. Burrs
    c. Shaft size
    d. Alignment
    e. Dirt
    f. Environment
    g. Installation
    h. All of the above.

Answers

1. Hot oil, light bulb,
2. d
3. b
4. h

DUTY: INSPECTING AND TROUBLESHOOTING EQUIPMENT

PERFORMANCE OBJECTIVE V-TECS 180

TASK: Inspect and troubleshoot pneumatic clutch and brake.

CONDITIONS: A mechanism with pneumatic clutch or brake and the following tools and equipment:

Inventory of replacement parts
Lock
Maintenance mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Plant/shop policy/procedures for disassembly/repair/replacement/discard
Tags
Wiping rags.

STANDARD: When completed, the worn and broken parts not in compliance with manufacturer's specifications will be identified and the decision for repair, replacement or discard will have been made.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Check plant/shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check machine/equipment manuals for authorized field repair.
4. Disassemble machine/mechanism to expose clutch or brake as necessary.
5. Remove all grease and dirt from clutch or brake.
6. Inspect the item for correct operation according to manufacturer's specifications.
7. Inspect for wear/damage or broken parts.
8. Determine cause of breakdown/malfunction.
9. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules. NOTE: It may be more cost-effective to get/keep equipment operational and eliminate cause of breakdown later.
10. Replace/repair/discard part(s) in accordance with manufacturer's manuals, shop practice, and supervisor's recommendations.
11. Clean parts before reassembly.
12. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #10.
13. Tag parts for repair, replacement, or discard as necessary.

PERFORMANCE OBJECTIVE V-TECS 180

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use knowledge of pneumatics.
Use knowledge of clutches and bearings.
Use knowledge of safety standards.
Use of service or maintenance manuals.

LEARNING ACTIVITIES

1. Demonstrate how to install lock out device on power supply.
2. Identify problem area.
3. Show how to clean and check all components for wear and determine whether to repair or replace.
4. Explain how clutch and brake function pneumatically and mechanically.
5. Demonstrate how to update maintenance service records.
6. Evaluate when completed, using evaluation standards.

RESOURCES

Manufacturer's Specifications.

Oberg, et al. **Machinery Handbook**, pp. 700-706.

EVALUATION

Questions
1. Pneumatic Clutch or brake operates on:
   a. Hydraulic pressure
   b. Electricity
   c. Air pressure
   d. All of the above.
2. Which statement is most true:
   a. A pneumatic clutch works on friction.
   b. A pneumatic clutch is a positive drive.
   c. A pneumatic clutch has a piston.
   d. All of the above.
3. Failure of a pneumatic clutch may not be due to the clutch itself but its support equipment.
   (True or False)

Answers
1. c
2. c
3. True

DUTY: INSPECTING AND TROUBLESHOOTING EQUIPMENT

PERFORMANCE OBJECTIVE V-TECS 181

TASK: Inspect and troubleshoot drive coupling.

CONDITIONS: A mechanism with malfunctioning drive coupling, cleaning fluid and the following tools and equipment:

Inventory of replacement parts
Maintenance mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Plant/shop policy/procedures for disassembly/repair/replacement/discard
Tags
Wiping rags.

STANDARD: When completed, the worn and broken parts not in compliance with manufacturer's operating specifications will have been identified and the decision for repair, replacement, or discard will have been made.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Check plant/shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check machine/equipment manuals for repair/disassembly.
4. Disassemble machine/mechanism to expose drive coupling as necessary.
5. Remove all grease and dirt from coupling.
6. Inspect the coupling for freedom of operation.
7. Check for broken parts, wear or damage.
8. Determine cause of breakdown/malfunction.
9. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules. NOTE: It may be more cost-effective to get/keep equipment operational and eliminate cause of breakdown later.
10. Replace, repair, discard part(s) in accordance with manufacturer's manuals, shop practice and supervisor's recommendations.
11. Check coupling for correct operation according to manufacturer's specifications.
12. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #10.
13. Tag parts for repair, replacement, or discard as necessary.

PERFORMANCE OBJECTIVE V-TECS 181

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use knowledge of couplings.
Use knowledge of safety standards.

LEARNING ACTIVITIES

1. Demonstrate how to install lock out device on power supply.
2. Identify coupling problem as probably the cause for problem.
3. Explain proper procedures for checking coupling alignment.
4. Explain how to determine if coupling can be salvaged or replaced.
5. Update maintenance service records.
6. Evaluate when completed, using evaluation questions.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 193-204.

EVALUATION

Questions

1. Explain the function of a drive coupling.
2. Which of the following is most true:
    a. Mill alignment is the cause of coupling failure.
    b. Vibration is biggest cause of coupling failure.
    c. Contamination is biggest cause of coupling failure.
3. On three piece couplings using a set screw for mounting to shaft explain how you would prepare shaft to accept set screw.

Answers

1. Couple two shafts.
2. a
3. Provide a flat, spot drill for set screw or machine circular groove in shaft.

DUTY: INSPECTING AND TROUBLESHOOTING EQUIPMENT

PERFORMANCE OBJECTIVE V-TECS 182

TASK: Inspect and troubleshoot centrifugal clutch.

CONDITIONS: A mechanism with centrifugal clutch, cleaning fluid and the following tools and equipment:

Inventory of replacement parts
Lock
Maintenance mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Plant/shop policy/procedures for disassembly/repair/replacement/discard
Tags
Wiping rags.

STANDARD: When completed, the worn and damaged parts not in compliance with manufacturer's operating specifications will have been identified and the decision for repair, replacement, or discard will have been made.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Check plant/shop procedures/policy for authorized field assembly/disassembly and repair replacement/discard of parts.
3. Check machine/equipment manuals for authorized field repair.
4. Disassemble machine/mechanism to expose clutch as necessary.
5. Remove all grease and dirt from clutch.
6. Inspect the clutch for correct operation according to manufacturer's specifications.
7. Check for broken parts, wear marks and damage.
8. Determine cause of breakdown/malfunction.
9. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules. NOTE: It may be more cost-effective to get/keep equipment operational and eliminate cause of breakdown later.
10. Replace/repair/discard part(s) in accordance with manufacturer's manuals, shop practice and supervisor's recommendations.
11. Check clutch operation according to manufacturer's specifications.
12. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #10.
13. Tag parts for repair, replacement, or discard as necessary.

PERFORMANCE OBJECTIVE V-TECS 182

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use knowledge of centrifugal clutches.
Use knowledge of safety standards.

LEARNING ACTIVITIES

1. Demonstrate how to install lock on device on power supply.
2. Identify malfunction of centrifugal clutch as cause of malfunction.
3. Demonstrate how to clean and check all components for wear and determine whether to repair or replace.
4. Demonstrate how to reassemble unit in accordance with manufacturer's specifications.
5. Demonstrate how to update maintenance service records.
6. Evaluate when complete, using evaluation questions.

RESOURCES

Manufacturer's Specifications.

Oberg, et al. **Machinery Handbook,** pp. 700-706.

EVALUATION

Questions

1. Explain how a centrifugal clutch works.
2. A centrifugal clutch is a positive drive.
   (True or False)
3. Which of the following will provide the smoothest start of a drive ?
   a. Electric clutch
   b. Pneumatic clutch
   c. Centrifugal clutch
   d. All of the above.

Answers

1. Centrifugal force
2. False
3. c

DUTY: INSPECTING AND TROUBLESHOOTING EQUIPMENT

PERFORMANCE OBJECTIVE V-TECS 183

TASK: Inspect and troubleshoot rack and pinion drive.

CONDITIONS: A malfunctioning mechanism with rack and pinion drive cleaning fluid and the following tools and equipment:

Inventory of replacement parts
Lock
Maintenance mechanic's tool box (handtools)
Manufacturer's specifications
Personal safety equipment
Plant/shop policy/procedures for disassembly/repair/replacement/discard
Tags.

STANDARD: When completed, the worn and damaged parts not in compliance with manufacturer's operating specifications will have been identified and the decision for repair, replacement, or discard will have been made.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Check with supervisor or check plant and/or shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check machine/equipment manuals for authorized field repair.
4. Disassemble machine/mechanism to expose rack and pinion as necessary.
5. Remove all grease and dirt from item.
6. Inspect the rack and pinion for missing teeth, loose bolts, broken parts.
7. Inspect the teeth for damage, wear and correct form according to manufacturer's specifications.
8. Inspect for causes of breakdown/malfunction.
9. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules.
10. Replace/repair/discard part(s) in accordance with manufacturer's manuals, shop practice, and supervisor's recommendations.
11. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #10.
12. Tag parts for repair, replacement, or discard as necessary.

PERFORMANCE OBJECTIVE V-TECS 183

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use knowledge of gears.
Use knowledge of safety standards.

LEARNING ACTIVITIES

1. Demonstrate how to install lock out device on power supply.
2. Show how to inspect rack and pinion drive and identify problem.
3. Demonstrate how to clean and inspect all parts and determine whether to repair or replace.
4. Demonstrate how to update maintenance records.
5. Evaluate after completion, use evaluation questions.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 145-164.

EVALUATION

Questions

1. Match the following:

a. Rack and Pinion	Right angle drive
b. Spur Gear	Used to change speed
c. Miter Gears	Rotary to linear motion.

2. The ratio of a rack and pinion drive is ______________.
3. How do you determine the proper clearance of a rack and pinion drive?
4. Assume you have installed a new rack and pinion and you have excessive clearance, how would you correct this?

Answers

1. c, b, a
2. 1-1
3. Judgment
4. Shim Rack

DUTY: INSPECTING AND TROUBLESHOOTING EQUIPMENT

PERFORMANCE OBJECTIVE V-TECS 184

TASK: Inspect and troubleshoot open gear/gear box drives.

CONDITIONS: A mechanism with gear box drive, cleaning fluid, lubricant and the following tools and equipment:

Arbor press
Bearing pullers
Lock
Maintenance mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Plant/shop policy/procedures for disassembly/repair/replacement/ discard
Tags
Wiping rags.

STANDARD: When completed, all worn and damaged parts not in compliance with manufacturer's operating specifications will have been identified, the decision to repair, replace, or discard will have been made, and the mechanism will operate in accordance with manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out equipment power.
2. Check with supervisor or plant/shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check machine/equipment manuals for authorized field repair.
4. Disassemble mechanism to expose gear box drive as necessary.
5. Remove grease and dirt from gear box. Drain oil.
6. Dismantle gear box and remove all gears and bearings.
7. Clean and check bearings for wear, damage, smoothness and freedom of operation.
8. Clean and check gears.
    a. Check for missing teeth, worn gaskets (cover seals).
    b. Check teeth for excessive wear and damage according to manufacturer's specifications.
    c. Check for worn keyways, keys, and bores.
9. Determine causes of damage/excessive wear/breakdown/malfunction.
10. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules. NOTE: It may be more cost-effective to get/keep machine/equipment operating as soon as possible and eliminate cause of breakdown later.

Performance Guide Continued

11. Replace/repair/discard worn and damaged parts as necessary in accordance with manufacturer's manuals, shop practice and supervisor's recommendations.
12. Reassemble gear box.
13. Fill with lubricant according to manufacturer's specifications.
14. Test operation in accordance with manufacturer's specifications.
15. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #1.
16. Tag parts for repair, replacement, or discard as necessary.

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of mechanic's stereoscope.
Use knowledge of gears.
Use of sight and hearing to verify proper operation.
Use knowledge of safety standards.

LEARNING ACTIVITIES

1. Demonstrate how to install lock out on power supply.
2. Demonstrate how to use service manual in troubleshooting.
3. Explain how to use a stereoscope to check problem areas.
4. Show how to clean all components for wear and determine whether to repair or replace.
5. Explain how to check for proper clearance between gears.
6. Demonstrate how to update maintenance service record.
7. Evaluate when completed using evaluation questions.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 145-164.

EVALUATION

Questions

1. Proper clearance between gear teeth is most important check of the following:
    a. .062
    b. .010
    c. .003 - .005
    d. None of the above.

Evaluation Continued

2. Which of the following leads to gear box failure?
   a. Lack of maintenance
   b. Lack of lubrication
   c. Wrong gear box for application
   d. All of the above.
3. Taper roller bearings are often used in a gear box. Explain what is meant by preload and how do you adjust for preload?
4. You have two gear boxes.
   A. Spur gears drive shaft has a 30 tooth gear turning at 15 RPM driving a 20 tooth gear on the out put shaft. What is speed of out put shaft?
   B. A double lead worm on the input shaft and a 60 tooth worm gear on the out put shaft, what is the ratio and what is the speed of out put shaft if input shaft turns 300 RPM?

Answers
1. d
2. d
3. a. Preload is a load within the bearing either built in or by adjustment.
   b. You adjust for preload by a preload adjustment nut.
4. A. 22.5 RPM
   B. Ratio 30-1
   RPM - 10

DUTY: INSPECTING AND TROUBLESHOOTING EQUIPMENT

PERFORMANCE OBJECTIVE V-TECS 185

TASK: Inspect and troubleshoot belt/variable speed drives.

CONDITIONS: A machine containing a malfunctioning belt drive, cleaning fluid and the following tools and equipment:

Lock
Maintenance mechanic's tool box (hand tools)
Manufacturer's specifications
Personal safety equipment
Plant/shop policy/procedures for disassembly/repair/replacement/discard
Tags
Wiping rags.

STANDARD: When completed, all worn and damaged parts not in compliance with manufacturer's specifications will have been identified, the decision to repair, replace, or discard will have been made and the mechanism will operate according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Check plant/shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check machine/equipment manuals for authorized field repair.
4. Remove guards if necessary.
5. Remove grease and dirt from belt drive.
6. Inspect belts for wear, damage and tension.
7. Inspect pulleys and bearings for damage and wear.
8. Determine causes of excessive wear and damage to parts.
9. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules. NOTE: It may be cost-effective to get/keep machine operational and eliminate cause of breakdown later.
10. Replace/repair/discard part(s) in accordance with manufacturer's manuals, shop practice and supervisor's recommendations.
11. Replace guards.
12. Start machine and check operation according to manufacturer's specifications.
13. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #10.
14. Tag parts for repair, replacement, or discard as necessary.

PERFORMANCE OBJECTIVE V-TECS 185

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use knowledge of variables speed belt drives.
Use knowledge of safety standards.
Use of sight and hearing to verify proper operation.

LEARNING ACTIVITIES

1. Demonstrate how to install lockout on power supply.
2. Demonstrate how to use service manual to troubleshoot.
3. Clean and check all components for wear or damage. Identify those in need of repair or replacement.
4. Demonstrate how to update maintenance service manual.
5. Explain how to identify the cause of problem.
6. Evaluate when completed, using evaluation questions.

RESOURCES

Manufacturer's Specifications.

EVALUATION

Questions

1. Explain the function of a variable speed belt drive. How does it change speed?
2. Variable speed belt drives require a lot of maintenance. Check the problem areas.
   a. Belt
   b. Contamination
   c. Cone pulley
   d. Springs
   e. Motors
   f. Lubrication
   g. All of the above.
3. Variable speed belt drives are more or less efficient than a variable speed chain drive.

Answers

1. Judgment
2. g
3. Less

DUTY: INSPECTING AND TROUBLESHOOTING EQUIPMENT

PERFORMANCE OBJECTIVE V-TECS 186

TASK: Inspect and troubleshoot chain drive.

CONDITIONS: A machine containing a chain drive, cleaning fluid and the following tools and equipment:

Chain breaker
Lock
Maintenance mechanic's handbook (handtools)
Manufacturer's specifications
Personal safety equipment
Plant/shop policy/procedures for disassembly/repair/replacement/discard
Tags
Wiping rags.

STANDARD: When completed, all worn and damaged parts not in compliance with manufacturer's specifications will have been identified, the decision to repair, or discard will have been made, and the machine will operate according to manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Lock out machine power.
2. Check plant/shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check machine/equipment manuals for authorized field repair.
4. Remove guards as necessary.
5. Remove master link and chain.
6. Clean and inspect chain for broken/worn parts.
7. Inspect sprockets for broken/worn teeth in accordance with manufacturer's specifications.
8. Determine causes of excessive wear and damage.
9. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules. NOTE: It may be more cost-effective to get/keep machine operational and eliminate cause of breakdown later.
10. Adjust chain tension to manufacturer's specifications.
11. Replace guards.
12. Start machine and check operation in accordance with manufacturer's specifications.
13. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #9.
14. Tag parts for repair, replacement, or discard as necessary.

PERFORMANCE OBJECTIVE V-TECS 186

ENABLING OBJECTIVES

Use of hand tools.
Use of measuring tools.
Use of straightedge.
Use knowledge of chain drives.
Use knowledge of safety.

LEARNING ACTIVITIES

1. Demonstrate how to install lock out device on power supply.
2. Explain how to evaluate performance of chain drive as is before working on it. Refer to service manual if necessary.
3. Demonstrate how to clean and check all components for wear. Repair and replace.
4. Explain how to evaluate if chain drive is properly guarded. If not, do it.
5. Explain how to update maintenance service records.
6. Evaluate when completed, using evaluation questions.

RESOURCES

Manufacturer's Specifications.

Anderson, Edwin P., **Audels Millwrights and Mechanics Guide**, pp. 165-192.

EVALUATION

Questions

1. A chain drive is dangerous for many reasons; check the following you feel could be dangerous:
   a. Loose chain
   b. Improper guarding
   c. Badly worn sprockets
   d. Oily chain
   e. All of above.
2. Which of the following is true?
   a. A chain drive transmits energy.
   b. A chain drive transmits linear motion.
   c. A chain drive transmits rotary motion.
   d. All of above.
3. If roller chains come in 10 feet lengths and you need only 3 feet, what is the professional way to disassemble the chain?
4. On most all roller chain there is a marking on it such as 40 or 50. What does this tell you?

PERFORMANCE OBJECTIVE V-TECS 186

Evaluation Continued

Answers

1. e
2. d
3. Chain buster
4. 40 = 4/8 or 1/2" pitch
   50 = 5/8 or 5/8" pitch

SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 187

TASK: Assign work responsibilities to workers.

CONDITIONS: A work order indicating job specifications to be accomplished, criteria for prioritizing work assignments, current workloads, employee capabilities and the following tools and equipment:

Employee job descriptions
Employee personnel files
Tool/equipment list form
Writing instrument.

STANDARD: When completed, the maintenance mechanic will be assigned according to priorities' criteria, workload and capabilities, and scheduled for completion of the assignment within due dates.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Analyze work order for skills, knowledge , tools needed, criticality, priority, and deadlines.
2. Analyze availability of employees capable of doing the job by reviewing past performance and personnel files as necessary.
3. Prepare tool list for the job.
4. Select the employee for the work assignment.
5. Give work order and tool list to employee to read.
6. Instruct employee to do the following:
   a. Inform contact person before and after work assignment.
   b. Record time and materials.
   c. Return work order for logging.
   d. Ask for assistance if unable to complete the work assignment.
7. Ask employee if there are any questions or need for further explanation.
8. List assignment on master record sheet as necessary.

ENABLING OBJECTIVES

Use forms for tools and equipment.
Use of personnel files.
Recognize job assignment.

PERFORMANCE OBJECTIVE V-TECS 187

LEARNING ACTIVITIES

1. Discuss what qualities and skills are needed to accomplish the task.
2. Emphasize the importance of complete tool list for the task.
3. Explain how to make assignments to capable subordinates.
4. Discuss the importance of appropriate communications.
5. Discuss how to formulate special safety considerations.

RESOURCES

Black. **The Basics of Supervisory Management: Mastering The Art of Effective Supervision.**

EVALUATION

Questions

1. When assigning job responsibilities the primary consideration should be:
   a. Skill
   b. Knowledge
   c. Length of service
   d. Attitude of cooperation.
2. Without good communication productivity will suffer.
   (True or False)
3. All a supervisor needs is one good man, the others don't need training.
   (True or False)

Answers

1. d
2. True
3. False

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 188

TASK: Order materials needed for a job.

CONDITIONS: A work order specifying materials for a job and the following tools and equipment:

Budget
Order form
Purchasing policy/procedures manual
Supply/materials catalogs
Supply/materials inventory
Writing instrument.

STANDARD: When completed, the necessary materials will be ordered in accordance with purchasing policies, procedures and budget.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Review purchasing policies/procedures as necesssary.
2. Verify availability of materials on inventory.
3. Obtain order form.
4. Consult vendor catalogs and compare prices of items needed.
5. Consult budget as necessary.
6. List following on order form as necessary:
    a. Dates
    b. Catalog number
    c. Material description
    d. Quantity
    e. Price.
7. Submit to purchasing department or supervisor for authorization/approval.

ENABLING OBJECTIVES

Use of vendors catalog.
Use of requisitions.
Use of budget and purchasing policies.

LEARNING ACTIVITIES

1. Discuss how to identify price and selection from vendors catalogs.
2. Emphasize the importance of establishing delivery dates.
3. Demonstrate inventory procedures.

PERFORMANCE OBJECTIVE V-TECS 188

Learning Activities Continued

4. Show how to prepare order forms listing all necessary data.
5. Explain the need to have requisition proof read and approved.

RESOURCES

Vendor Catalogs.

EVALUATION

Questions

1. It is all right to order more than needed if an item is commonly used. (True or False)
2. Which is more important price or quality?
3. If the boss trusted your judgment, you send an order without his approval.
   (True or False)

Answers

1. True
2. Quality
3. False

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 189

TASK: Conduct safety training program.

CONDITIONS: A list of employees, time period, learning environment(s) and the following tools and equipment:

Apron
Audio visual projector(s)
Chalkboard or easel
Company safety record
Eye washer
Facilities floor plan
Fire blanket
Fire extinguisher
Fire hose
First-aid kit
Injury reporting form
Manufacturer's safety manuals
Masks
Occupational Safety and Health Act (OSHA) standards
Organization health and safety policies/procedures/rules
Personal safety equipment
Personnel records
Pull box
Resuscitation mock-up/aid
Safety shower
Screen.

STANDARD: When completed, the training program will have apprised employees of organizational health and safety policies and procedures, and employees will have participated in fire drills, first aid activities and other specific safety activities.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen. **Developing Troubleshooting Skills,** pp. 101-103.

PERFORMANCE GUIDE

1. Review organization's health and safety policies and procedures.
2. Review organization's safety record.
3. Review safety standards of OSHA.
4. Review safety training needs of employees by assessing employees' backgrounds and experience.
5. Plan safety training program to cover topics as necessary.
6. Obtain training aids and resource persons as necessary.

Performance Guide Continued

7. Invite/schedule/announce/assemble employees.
8. Introduce subject topics.
9. Present key points.
    a. Organizational safety regulations, policies, procedures, safety records, accident reporting procedures.
    b. Safety standards of OSHA.
    c. Procedures in case of fire, tornado or other emergency.
    d. Organization's health and safety personnel.
    e. Safety on various machines and equipment.
10. Demonstrate/illustrate procedures as necessary. Tour plant or distribute/discuss floor plans as necessary to point out fire exits, fire extinguishers, fire hoses, pull boxes, fire blankets, first aid equipment.
11. Provide for learner participation. Conduct fire drill, practice first aid procedures and specific safety precautions as necessary.
12. Evaluate and obtain feedback for further safety training.
13. Request or coordinate further health and safety training such as first aid, cardio-pulmunary resuscitation (CPR).

ENABLING OBJECTIVES

Use of safety equipment, fire extinguisher, safety showers.
Use of OSHA standards.
Use of safety records.

LEARNING ACTIVITIES

1. Discuss the three basic elements which cause a fire to start.
2. Have the student demonstrate the use of a fire blanket.
3. Discuss the list of safety compliance checks.
4. Emphasize the need for use of personal safety equipment.
5. Simulate an emergency situation involving a stretcher case.

RESOURCES

OSHA Standard.

EVALUATION

Questions

1. In all fire drills, females and seniors go first.
   (True or False)
2. If injured, no matter how slightly, report to medical facility for treatment.
   (True or False)

3. For foreign object in an eye you should:
   a. Wash with water.
   b. Report to medical facility for treatment.
   c. Both.

Answers
1. False
2. True
c. Both

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 190

TASK: Schedule labor needed for job.

CONDITIONS: A work order indicating job specifications to be accomplished, criteria for prioritizing work assignments, current work loads, employee capabilities and the following tools and equipment:

Employee job descriptions
Employee personnel records
Estimating sheet or form
Flat rate manual
Inventory of machines/equipment/tools
Inventory of supplies/replacement parts
Manufacturer's manuals
Project time sheet
Schedules of maintenance/repair to be done
Union contracts
Writing instrument.

STANDARD: When completed, the crew will be formulated and assigned and scheduled in accordance with the skills and knowledge needed, priorities established, and the time schedules required.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Analyze work order(s) for skills, knowledge, tools, and equipment needed, criticality, priority and deadlines.
2. Analyze availability of employee skills and knowledge for the work order(s) by reviewing job descriptions, past performances, personnel records, work loads and priorities, as necessary.
3. Analyze availability of tools, equipment and materials for the job.
4. Estimate total downtime such as travel, lunches, breaks, task performance.
5. Prepare list of tools/equipment/materials for the job.
6. Identify/select employees for the crew job.
7. Brief the affected department/area supervisor or shop foreman of the scope of work and total estimate of downtime.
8. Coordinate beginning and ending times with department/area supervisory/shop foreman.
9. Assign/orient crew by reviewing the work order(s).
10. Evaluate work of the crew.
11. Provide feedback to crew as necessary.

PERFORMANCE OBJECTIVES V-TECS 190

ENABLING OBJECTIVES

Identify job specifications.
Use of tools and equipment.
Use of estimating form.
Use of personnel records.

LEARNING ACTIVITIES

1. Discuss the importance of reviewing the work to be done with those doing it.
2. Have student make a list of all special tools and equipment.
3. Discuss the need to estimate total hours needed for a job, coordinating it with the area contact person.
4. Assign work to fit priorities and available employee skills.
5. Review procedure for evaluating.

RESOURCES

Bittel. **What Every Supervisor Should Know.** Chapter 36 p. 309.

EVALUATION

Questions

1. After assigning individual jobs to employees the boss's job is finished. (True or False)
2. Which is more important?
   a. Getting the job done on time
   b. Complying with safety regulations.
3. Which is best?
   a. To cover up mistakes if possible
   b. Inform supervisor and let him handle it.

Answers

1. False
2. b.
3. b.

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 191

TASK: Prepare (nonpreventive) maintenance/repair schedules.

CONDITIONS: A list of equipment, cost estimates and the following tools and equipment:

Calendar
Equipment manufacturer's manuals
Estimating form
List of maintenance mechanics
Machine/equipment past maintenance/repair records
Production schedules
Writing instrument.

STANDARD: When completed, schedule must include all equipment, type of maintenance and repair for each piece of equipment, description of crew, and time schedule for each piece of equipment.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen. **Developing Troubleshooting Skills**, pp. 145-160.

PERFORMANCE GUIDE

1. Identify/classify type of equipment to be maintained/repaired.
   a. Stationary
   b. Portable
   c. Electrical
   d. Mechanical
   e. Nuclear.
2. Review machinery/equipment past maintenance/repair performance records.
3. Review plant production schedules.
4. Select and apply maintenance criteria other than preventive maintenance.
   a. Failure
   b. Efficiency
   c. Sound
   d. Color
   e. Temperature
   f. Vibration
   g. Odor
   h. Complaint
   i. Speed
   j. Wear
   k. Force
   l. Mass.

PERFORMANCE OBJECTIVE V-TECS 191

Performance Guide Continued

5. Identify skills/competencies needed for each piece of equipment.
6. Estimate crew size and maintenance specialists needed.
7. Estimate completion time.
8. Select tools for each piece of equipment.
9. Select parts for each piece of equipment.
10. Determine starting times.
11. Prepare schedules.

ENABLING OBJECTIVES

Use of maintenance equipment.
Identify skilled personnel.
Use of calendar.
Interpret production schedules.

LEARNING ACTIVITIES

1. Explain the type of equipment to be repaired and select the tools needed for repair.
2. Have student review past history of equipment repair.
3. Explain the signs of equipment failure such as noise, temperature and vibration.
4. Have student identify the critical points of wear.
5. Discuss how to establish time schedule in hours work per task.

RESOURCES

Bittel. **What Every Supervisor Should Know.** Chapter 31 p. 314.

EVALUATION

Questions

1. In a nonpreventive situation you should:
   a. Expect the priorities to change
   b. Start a new job before you have finished the first
   c. Let the boss handle priorities.
2. In selecting parts for equipment, the parts list and price usually accompany manufacturer's manual.
   (True or False)
3. If a part does not fit you should ________________________.

Evaluation Continued

Answers
1. c
2. True
3. Consult the manufacturer's representative.

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 192

TASK: Prepare preventive maintenance schedule(s).

CONDITIONS: A list of equipment and preventive maintenance schedules for each piece of equipment and the following tools and equipment:

Manufacturer's manuals for all equipment
Preventive maintenance recording or cataloging form/schedule
Writing instrument.

STANDARD: When completed, the master preventive maintenance schedule must include preventive maintenance schedule for all pieces of equipment in accordance with manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen. **Developing Troubleshooting Skills.** pp. 145-160.

PERFORMANCE GUIDE

1. Identify equipment from list provided.
2. Classify equipment.
   a. Stationary
   b. Portable
   c. Electrical
   d. Mechanical
   e. Nuclear.
3. Review manufacturer's specifications for preventive maintenance for each piece of equipment.
4. Select preventive maintenance criteria.
   a. Length of time
   b. Usage factor - heavy usage, light usage
   c. Distance
   d. Wear indicator
   e. Level/type of maintenance.
5. Estimate crew, skills/size needed for each piece of equipment.
6. Estimate task time for each piece of equipment.
7. List tools needed for each preventive maintenance task.
8. List parts/supplies anticipated for each preventive maintenance task.
9. Analyze usage factor for each piece of equipment.
10. Catalog all information gathered from steps 1-9 for all equipment.
11. Prepare master preventive maintenance schedule.

PERFORMANCE OBJECTIVE V-TECS 192

ENABLING OBJECTIVES

Use of maintenance equipment.
Use of manufacturer's manuals.
Use of maintenance records.

LEARNING ACTIVITIES

1. Have the students list and classify all maintenance equipment.
2. Explain the steps in keeping a maintenance records system.
3. Have the students identify the special equipment tools.
4. Demonstrate how to establish a "Parts on Hand List" and total inventory list.
5. Have student write preventive maintenance procedure for a piece of equipment.

RESOURCES

Bittel. **What Every Supervisor Should Know.** Chapter 31, p. 374.

EVALUATION:

Questions

1. A good inventory system ____________ lacks parts for maintenance.
    a. Never
    b. Sometimes
    c. Always
2. Preventive maintenance requires the scrapping of all parts that are worn.
   (True or False)
3. The purpose of a preventive maintenance program is to insure against unscheduled shut down.
   (True or False)

Answers

1. a
2. True
3. True

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 193

TASK: Record preventive maintenance activities.

CONDITIONS: A preventive maintenance recording form and the following tools and equipment:

File cabinet
Manufacturer's specifications
Preventive maintenance recording/cataloging form
Writing instrument.

STANDARD: When completed, preventive maintenance form must include all preventive maintenance activities performed and required, and findings needing further maintenance, repair or replacement in accordance with manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen. **Developing Troubleshooting Skills,** pp. 152-160.

PERFORMANCE GUIDE

1. Analyze work orders for preventive maintenance performed.
2. Check maintenance performed against manufacturer's specifications.
3. Obtain/initiate preventive maintenance form for each piece of equipment as necessary.
4. Record the following for each piece of equipment:
   a. Preventive maintenance performed
   b. Crew members
   c. Miscellaneous remarks other than covered on form
   d. Serial numbers
   e. Part numbers
   f. Service date
   g. Task time.
5. Record/report discrepancies/maintenance/repair yet to be done.

ENABLING OBJECTIVES

Use of maintenance records.
Use of manufacturer's manuals.
Use of skills.

PERFORMANCE OBJECTIVE V-TECS 193

LEARNING ACTIVITIES

1. Explain the steps involved in setting up preventive maintenance records.
2. Have student to write preventive maintenance form for a piece of equipment.
3. Discuss how a piece of equipment can best be serviced.
4. Demonstrate how to identify, by serial number, similar pieces of equipment.
5. Explain how to select persons assigned to making repairs.

RESOURCES

Bittel. **What Every Supervisor Should Know.** Chapter 31, p. 374.

EVALUATION

Questions

1. Only those items which are important should be kept on record. (True or False)
2. It is permissable to use jobber parts in place of manufacturer's parts. (True or False)
3. If repair has yet to be done you should:
   a. Wait until next time.
   b. Reschedule.
   c. Forget it.

Answers

1. True
2. True
3. b

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 194

TASK: Evaluate preventive maintenance program.

CONDITIONS: A preventive maintenance program in existence for at least one year, with costs' estimates, equipment performance recorded and the following tools and equipment:

Calculator
Equipment manufacturer's service manuals
Work sheet
Writing instrument.

STANDARD: When completed, evaluation report must include analysis of comparisons with previous costs and downtime of equipment.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen. **Developing Troubleshooting Skills,** pp. 145-160.

PERFORMANCE GUIDE

1. Analyze/evaluate costs of the preventive maintenance program in comparison to previous preventive maintenance program.
2. Analyze/evaluate equipment usage performance, repair, downtime in comparison to previous comparable time period.
3. Answer following questions:
    a. Have unscheduled outages or need for major maintenance at inconvenient times been reduced?
    b. Has asset life been extended or predicted life of equipment been attained as per usage factors and manufacturer's estimates?
    c. Have early warnings of major maintenance occurred?
    d. Has cost-effectiveness of PM program been improved?
4. Prepare evaluation report.

ENABLING OBJECTIVES

Use of equipment records.
Identify cost estimates.
Use of tools, calculator.

LEARNING ACTIVITIES

1. Discuss the effectiveness of a preventive maintenance program.
2. Identify the cost reduction due to preventive maintenance program.

PERFORMANCE OBJECTIVE V-TECS 194

LEARNING ACTIVITIES

3. Emphasize areas where a preventive maintenance program has reduced unscheduled outages.
4. Show how preventive maintenance program has been cost effective.
5. Show how life expectancy has been affected by a preventive maintenance program.

RESOURCES

Jansen. **Developing Troubleshooting Skills,** pp. 145-160.

EVALUATION

Questions

1. Is a good preventive maintenance program worth the effort?
   a. Very much
   b. Little worth
   c. About the same.
2. A good preventive maintenance program is proportional to production output.
   (True or False)
3. Who benefits most from preventive maintenance programs?
   a. Employee
   b. Company
   c. Customers
   d. All of these.

Answers

1. a
2. True
3. d

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 195

TASK: Observe/evaluate corrective maintenance/repair on machinery.

CONDITIONS: A schedule of maintenance/repair being performed on machinery, a time period for observing/evaluating the corrective maintenance and the following tools and equipment:

Maintenance report forms
Manufacturer's maintenance/repair manuals
Personal safety equipment
Work orders.

STANDARD: When completed, the corrective maintenance/repair will have been observed/evaluated, manufacturer's maintenance manuals reviewed, and an evaluation report of the corrective maintenance completed. The report will be compatible with the maintenance work order requests and the manufacturer's specifications.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Review work orders for maintenance/repair requested.
2. Select the machine/pieces of equipment for observation.
3. Review manufacturer's specifications for maintenance/repair.
4. Inspect work area for cleanliness, orderliness and safety as necessary.
5. Observe/record maintenance/repair being performed.
6. Make comparative analysis of a maintenance/repair being performed with manufacturer's maintenance/repair specifications.
7. Prepare evaluative report.

ENABLING OBJECTIVES

Use maintenance report.
Use manufacturer's manuals.
Use personal protective equipment.

LEARNING ACTIVITIES

1. Discuss the difference between scheduled maintenance and preventive maintenance.
2. Have student prepare manufacturer's recommendations and specifications.
3. Describe procedures for safety and housekeeping evaluation.

Learning Activities Continued

4. Review manufacturer's specifications and work order for compatibility.
5. Demonstrate how to conduct an evaluation of maintenance repairs.

RESOURCES

Jansen. **Developing Troubleshooting Skills.**

EVALUATION

Questions

1. The primary concern in all maintenance is the safety attitude of skilled workers.
   (True or False)
2. The manufacturer's specifications should be followed.
   a. Always
   b. Sometimes
   c. Never.

3. If an unfamiliar action occurs, report it immediately to your supervisor.
   (True or False)

Answers

1. True
2. Always
3. True

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 196

TASK: Hire personnel.

CONDITIONS FOR PERFORMANCE OF TASK: A job description, competencies required for the position, at least three completed applications for a position, and reports of interviews with prospective employees and the following tools and equipment:

Company hiring policies/procedures
Personnel rating scales.

STANDARD: When completed, the applicants' education, training, and work experience will have been reviewed, and attitudes toward work, level of interest in the position, general appearance, communication skills and other attributes relevant to the position will have been assessed. The applicants' qualifications will be evaluated in terms of the job descriptions and position requirements. The applicants will be ranked in order of preference for the position.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Review hiring policies and procedures.
2. Review the job requirements and position description of the vacancy.
3. Notify personnel or higher management of vacancy.
4. Review or develop hiring criteria, rating scales or tests for the position. Recommend salary rates.
5. Review and rate applicant's application material in accordance with hiring criteria and rating scales.
6. Review results of interviews.
   a. Set up interview panel if necessary.
   b. Develop interview questions if necessary.
7. Rate applicants on basis of interviews.
8. Rate applicants on basis of overall potential contribution and success with the company.
9. Rank the applicants.
10. Obtain approval to employ top ranked applicant.
11. Notify successful applicant.

ENABLING OBJECTIVES

Recognize company policies.
Interpret company pay scales.
Use of interview techniques.

PERFORMANCE OBJECTIVE V-TECS 196

LEARNING ACTIVITIES

1. Explain the policies most often found in large companies.
2. Discuss the need for testing applicants.
3. Have students role-play "Hiring an Applicant" and "Evaluating Potential Candidates."
4. Emphasize the need of self assurance.
5. Discuss the details of hiring which include the qualifications, education, experience and certification of the potential employee.

RESOURCES

A sample of a company personnel policy.

EVALUATION

Questions

1. Why should an applicant's personal appearance be of any consequence?
   a. Shows self dicipline
   b. Shows he needs a job
   c. Shows he's a hard worker.
2. Lack of communication skill loses more jobs than lack of job skills. (True or False)
3. Most job seekers are looking for a company that offers the best:
   a. Pay
   b. Benefits
   c. Local
   d. All the above.

Answers

1. a
2. True
3. d

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 197

TASK: Dismiss (terminate) employees.

CONDITIONS: An employee with unsatisfactory work performance and the following tools and equipment:

Company personnel policies/procedures on termination of employment
Labor laws relevant to termination of employment
Personnel records
Union contract
Witness statements as necessary.

STANDARD: When completed, the employee will have been counseled on alternatives available, rights and obligations. Termination will be based on valid evidence and in accordance with company/union/legal policies and procedures.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

PERFORMANCE GUIDE

1. Analyze cause for dismissal.
2. Review company policies and procedures for dismissal of employees.
3. Review legal aspects for dismissal of employees.
4. Review union contract for dismissal.
5. Collect relevant information from personnel files, witnesses.
6. Notify and discuss impending dismissal with employee.
7. Consider alternatives to dismissal.
8. Advise employee of dismissal if alternatives are unreasonable.
9. Prepare documentation and notify parties concerned.
10. Obtain clearances as necessary.
11. Notify terminated employee of rights, obligations and appeal procedures.
12. Determine, prepare and authorize final salary and termination payments due.

ENABLING OBJECTIVES

Interpret company policies.
Recognize existing laws.
Interpret union contracts.
Use of employee performance files.

PERFORMANCE OBJECTIVE V-TECS 197

LEARNING ACTIVITIES

1. Discuss reasons for dismissal such as tardiness, absenteeism, poor attitude, etc.
2. Explain counseling procedures or remedial programs, such as for alcohol rehabilitation.
3. Discuss the need to review performance files for past history.
4. Explain the difference between "Terminate" and "Immediate Dismissal."
5. Identify "Immediate Dismissal" cases like fighting, gambling, dishonesty, safety violations.

RESOURCES

Bittel. **What Every Supervisor Should Know.** Chapter 12, p. 133. Chapter 18, p. 212.

EVALUATION

Questions

1. Every employee should have the opportunity to tell his side or point of view.
   (True or False)
2. Termination should be a last resort.
   (True or False)
3. If terminated the person has a recourse under the legal system.
   (True or False)

Answers

1. True
2. True
3. True

DUTY: SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS

PERFORMANCE OBJECTIVE V-TECS 198

TASK: Orient employees to perform maintenance mechanic job activities.

CONDITIONS: A list of new maintenance mechanics with previous maintenance training and/or experience, classroom/orientation area and the following tools and equipment:

Floor plan of facilities, tool crib, spare parts, supplies, etc.
List of machines and equipment
Maintenance department policies/procedures manual with necessary report forms
Maintenance mechanic job descriptions and position requirements
New employee personnel files
Personal safety equipment.

STANDARD: When completed, the employees will be familiar with the maintenance department policies and procedures and their respective job activities.

SOURCE FOR STANDARD:
Wisconsin Writing Team.

Jansen. **Developing Troubleshooting Skills**, pp. 1-32.

PERFORMANCE GUIDE

1. Review previous training and experience of new employees.
2. Review job descriptions and position requirements.
3. Plan orientation session(s).
4. Greet/introduce new employees.
5. Present/discuss plant/department organization structure, policies and procedures such as chain of supervision, reporting forms, maintenance of security and communication.
6. Present/discuss specific maintenance mechanic job descriptions, tasks and requirements relevant to the job(s). Tour plant and orient to facilities, machines and equipment as necessary.
7. Demonstrate job tasks as necessary.
8. Ask for and discuss questions from new employees.

ENABLING OBJECTIVES

Use of facilities maintenance area.
Interpret policies.
Use employee files.
Use of personal protective equipment.

PERFORMANCE OBJECTIVE V-TECS 198

LEARNING ACTIVITIES

1. Discuss maintenance shop placement layout of power tools and benches.
2. Emphasize the use of personal safety equipment.
3. Discuss the value of reviewing maintenance mechanics job descriptions.
4. Explain the need for the security of system drawings.
5. Emphasize the need for good communications among all employees and management.

RESOURCES

Jansen. **Developing Troubleshooting Skills,** pp. 1-32.

EVALUATION

Questions

1. Why should you greet and introduce new members to your organization?
    a. It is good policy.
    b. Makes the newcomer feel welcome.
    c. Establishes good communications.
    d. All of the above.
2. Safety first is a good attitude.
   (True or False)
3. Good workers:
    a. Work as individuals.
    b. Work as a team.
    c. Combination of both.

Answers

1. d
2. True
3. c

APPENDICES

APPENDIX A

CROSS-REFERENCE TABLE OF DUTIES, TASKS AND PERFORMANCE OBJECTIVES

APPENDIX A

CROSS-REFERENCE TABLE OF DUTIES, TASKS AND PERFORMANCE OBJECTIVES

Project Code: 4001
O.E. Code: 17.99 Trade and Industrial Occupations, other
D.O.T. Code: 638.281-014 Maintenance Mechanic (Industrial Maintenance Mechanic)
No. of Respondents: 87

	Duty/Task	PO/Page Number
A.	ASSEMBLING AND DISASSEMBLING MACHINE MECHANISMS	
01.	Align and tension a belt drive.	1/5
02.	Maintain belt drives.	2/8
03.	Construct belt joints with mechanical fasteners.	3/11
04.	Construct belt joints with adhesives.	4/14
05.	Install, align and tension a chain and sprocket drive.	5/17
06.	Maintain chain and sprocket drives.	6/21
07.	Install and align closed gear drives.	7/24
08.	(A13) Maintain gear drives.	8/27
09.	Install and align flexible couplings.	9/29
10.	Remove and replace a composition friction type bearing seal.	10/32
11.	Remove and install mechanical seals.	11/35
12.	Align pillow blocks and bearings.	12/37
13.	Install pillow block bearings.	13/39
14.	Remove and install bearings in bores.	14/41
15.	Remove and install sleeve bearing in bores.	15/43
16.	Remove and install bearings on shafts.	16/46
17.	Straighten a shaft using a press.	17/49
18.	Replace a shaft.	18/51
19.	Install a shaft assembly.	19/53
20.	Align a shaft.	20/55

	Duty/Task	PO/Page Number
21.	Replace universal joint (U-Joint) assembly.	21/57
22.	Disassemble and reassemble universal joint (U-Joint).	22/59
23.	Adjust gibs for free operations.	23/61
24.	Install safety guards for conveyor system.	24/63
25.	Fabricate and install safety guards for conveyor system.	25/65
26.	Align drive mechanism for conveyor system.	26/67
27.	Assemble conveyor from component parts.	27/69
28.	Install conveyor into material handling system.	28/71
B.	MAINTAINING HYDRAULIC SYSTEMS	
01.	Replace and clean hydraulic strainer/filters.	29/74
02.	Refill hydraulic system.	30/76
03.	Align piston (rod) of hydraulic cylinder.	31/78
04.	Adjust hydraulic pressure.	32/80
05.	Replace hydraulic motor or pump.	33/82
06.	Align hydraulic pump or motor.	34/86
07.	Replace hydraulic gasket and seals.	35/88
08.	Install hydraulic line.	36/90
09.	Replace damaged or faulty hydraulic lines/ fillings/components.	37/92
10.	Replace valve in a hydraulic system.	38/94
11.	Measure pressure within a hydraulic system.	39/96
12.	Inspect pressure control (relief) valve.	40/98
13.	Measure flow within hydraulic system.	41/100
C.	INSTALLING AND REMOVING MACHINERY	
01.	Prepare area for machine installation.	42/103
02.	Raise machinery using jacks, bars and blocks.	43/105
03.	Transport machinery using fork lift.	44/107
04.	Transport machinery using overhead crane/ chainfall.	45/109
05.	Position and secure machinery on foundation.	46/111
06.	Align machinery.	47/113
07.	Connect machinery to electrical source.	48/115
08.	Connect machine to air or hydraulic source.	49/117

		Duty/Task	PO/Page Number
	09.	Paint machinery/equipment.	50/119
	10.	Block and brace equipment for moving or shipping.	51/121
	11.	Crib a piece of equipment to distribute the load over a larger area.	52/123
	12.	Move machine/equipment with skids or dollies.	53/125
D.	MAINTAINING AND REPAIRING HEATING/COOLING DEVICES		
	01.	Calibrate and adjust thermostat.	54/128
	02.	Lubricate air compressor.	55/131
	03.	Disassemble/reassemble air compressor.	56/133
	04.	Install air compressor.	57/135
	05.	Install/replace fan guards, shrouds or mesh covers.	58/137
	06.	Replace mechanical roof ventilators.	59/139
	07.	Clean and lubricate fans/ventilators.	60/141
	08.	Calibrate and adjust airflow controls.	61/143
	09.	Calibrate and adjust humidistats.	62/146
	10.	Calibrate and adjust pneumatic controls.	63/148
	11.	Calibrate and adjust pressure controls.	64/150
	12.	Replace air filters.	65/152
	13.	(D25) Assemble and disassemble a centrifugal/axial flow fan.	66/154
E.	MAINTAINING BOILERS		
	01.	Replace/install pipe insulation.	67/157
	02.	Replace/install check valves on water feed systems.	68/159
	03.	Replace/install cleanout plugs.	69/161
	04.	Install strainer/water filters.	70/163
	05.	Install piping and fittings.	71/165
	06.	Install tubing and fittings (exterior).	72/167
	07.	Install/replace steam traps.	73/169

	Duty/Task	PO/Page Number
F.	INSPECTING AND REPAIRING CRANE AND ELEVATORS	
01.	Inspect freight and personnel elevators.	74/172
02.	Adjust elevator doors/gates and guards.	75/174
03.	Install/replace cable on an electric cable drum hoist.	76/176
04.	Install/replace cable on a bridge crane.	77/178
05.	Inspect pulley(s) on cranes.	78/180
06.	Install/replace mechanical safety devices on cranes.	79/182
07.	Inspect tracks and runway areas.	80/184
08.	Install/replace runway tracks for cranes.	81/186
09.	Adjust mechanical brake.	82/188
G.	MAINTAINING TRACTORS AND TRUCKS	
01.	Complete a preventive maintenance report.	83/191
02.	Replace batteries.	84/193
03.	Install/replace water pump.	85/195
04.	Install/replace thermostat.	86/197
05.	Install/replace radiator/heater hoses.	87/199
06.	Install/replace brake shoes.	88/201
07.	Install/replace master cylinder.	89/204
H.	PERFORMING ELECTRICAL OPERATIONS	
01.	Remove/replace fuses.	90/207
02.	Test and replace faulty electrical control components.	91/209
03.	Change rotation of three-phase electric motor.	92/213
04.	Replace faulty electrical cords and plugs.	93/217
05.	Lubricate electric motor.	94/220

		Duty/Task	PO/Page Number
	06.	Install/replace electric motor.	95/224
	07.	Clean electric motor.	96/228
I.	PERFORMING WELDING OPERATIONS		
	01.	Braze ferrous/nonferrous metals with gas equipment.	97/233
	02.	Flame cut metal with equipment.	98/235
	03.	Gas weld ferrous/nonferrous metals.	99/237
	04.	Lead solder metals with gas equipment.	100/239
	05.	Silver braze metals with gas equipment.	101/241
	06.	Shape (form) metals using gas welding equipment.	102/243
	07.	Weld ferrous/nonferrous metals with MIG equipment.	103/245
	08.	Weld ferrous/nonferrous metals with TIG equipment.	104/247
	09.	Arc-weld ferrous/nonferrous metals.	105/249
	10.	Install/replace gas welding regulators.	106/254
	11.	Install/replace gas welding torches.	107/257
	12.	Anneal metals.	108/259
	13.	Harden metals.	109/261
	14.	Normalize metals.	110/263
	15.	Stress relieve metals.	111/265
	16.	Temper metals.	112/267
J.	PERFORMING CARPENTRY OPERATIONS		
	01.	Cut lumber to size with table saw.	113/270
	02.	Cut irregular shapes with band saw.	114/273
	03.	Cut lumber to size with handsaw.	115/276
	04.	Cut lumber to size with portable power saw.	116/279
	05.	Cut lumber to size with radial saw arm.	117/282
	06.	Construct and set forms for concrete work.	118/285
	07.	Construct and erect scaffolds.	119/289

Duty/Task PO/Page Number

08. Patch composition shingle/built-up roof. 120/292
09. Install/replace glass. 121/297

K. WORKING METAL WITH HAND OR PORTABLE TOOLS

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02. Cut threads with hand tools. 123/304
03. Cut threads with dies. 124/306
04. Hand lap/hone surfaces. 125/308
05. Hand scrape bearing (round) surfaces (Hand scrape bearing surfaces). 126/310
06. Ream holes with hand reamer. 127/312
07. Remove damaged screws and other threaded hardware. 128/314
08. Drill holes in metal with portable device. 129/316
09. Sharpen hand scrapers with abrasive stones (Sharpen hand scrapers). 130/318
10. Scrape flat surfaces for mating parts. 131/320
11. Grind surfaces with portable electric hand grinder. 132/322

L. PERFORMING DRILL PRESS OPERATIONS

01. Lubricate drill press. 133/325
02. Counterbore to depth with drill press. 134/333
03. Countersink with drill press. 135/337
04. Drill holes to size with drill press. 136/340
05. Hone hole with drill press. 137/343
06. Ream holes to size with drill press. 138/347
07. Spot-face hole with drill press. 139/351
08. Tap hole with drill press. 140/354
09. Bore hole with boring head on drill press. 141/358

M. PERFORMING GRINDING OPERATIONS

01. Clean and lubricate grinding machines. 142/362
02. Change coolant in grinding machine. 143/366
03. Cut off material with grinding machines. 144/370
04. Dress grinding wheel for internal/external grinding operations. 145/374
05. Grind cylindrical surface. 146/378

	Duty/Task	PO/Page Number
06.	Grind flat surface.	147/382
07.	Sharpen drill bits.	148/387
08.	Sharpen cutting tool bits.	149/390
09.	Sharpen hand tools, such as center punches/ chisels.	150/392
10.	Deburr with hand grinder.	151/397
N.	PERFORMING MILLING OPERATIONS	
01.	Bore out bushing.	152/402
02.	Cut external keyway.	153/406
03.	Cut internal keyslot using slotting attachments.	154/409
04.	Drill holes with milling machine.	155/412
05.	Clean and lubricate milling machine.	156/416
06.	Change coolant in milling machine.	157/420
07.	Mill angles.	158/423
08.	Mill horizontal/vertical surfaces.	159/430
09.	Ream hole to size.	160/433
O.	PERFORMING TURNING OPERATIONS	
01.	Bore hole with lathe.	161/437
02.	Counterbore hole with lathe.	162/441
03.	Cut internal threads with lathe.	163/446
04.	Cut external threads with lathe.	163/450
05.	Die cut threads with lathe using die head/stock/ wrench.	165/454
06.	Drill hole with lathe.	166/458
07.	Center drill hole with lathe.	167/462
08.	Face workpiece held in chuck on lathe.	168/465
09.	Turn contour/angular/radii cuts with lathe.	169/469
10.	Ream hole with lathe.	170/473
11.	Rechase thread on lathe.	171/477
12.	Tap thread with lathe.	172/482
13.	Cut short external taper on lathe using compound rest.	173/486
14.	Cut off workpiece held in chuck with parting tool.	174/490

		Duty/Task	PO/Page Number
P.		PERFORMING SHAPING AND CUTTING OPERATIONS	
	01.	Cut horizontal surface.	175/494
	02.	Cut metal stock with power hacksaw.	176/496
	03.	Cut metal shapes using shear.	177/498
Q.		INSPECTING AND TROUBLESHOOTING EQUIPMENT	
	01.	Inspecting and troubleshooting linkages and lever mechanisms.	178/501
	02.	Inspect and troubleshoot roller/ball bearings.	179/504
	03.	Inspect and troubleshoot pneumatic clutch and brake.	180/506
	04.	Inspect and troubleshoot drive couplings.	181/508
	05.	Inspect and troubleshoot centrifugal clutch.	182/510
	06.	Inspect and troubleshoot rack and pinion drive.	183/512
	07.	Inspect and troubleshoot open gear/gear box drives.	184/514
	08.	Inspect and troubleshoot belt/variable speed drives.	185/517
	09.	Inspect and troubleshoot chain drive.	186/519
R.		SUPERVISING MAINTENANCE AND REPAIR FUNCTIONS	
	01.	Assign work responsibilities to workers.	187/523
	02.	Order materials needed for a job.	188/524
	03.	Conduct safety training program.	189/527
	04.	Schedule labor needed for job.	190/530
	05.	Prepare (nonpreventive) maintenance/repair schedules.	191/532
	06.	Prepare preventive maintenance schedule.	192/535
	07.	Record preventive maintenance activities.	193/537
	08.	Evaluate preventive maintenance program.	194/539
	09.	Observe/evaluate corrective maintenance/repair on machinery.	195/541
	10.	Hire personnel.	196/543
	11.	Dismiss (terminate) employees.	197/545
	12.	Orient employees to perform maintenance mechanic job activities.	198/547

APPENDIX B

DEFINITION OF TERMS

APPENDIX B

DEFINITION OF TERMS

The following are supplied to establish operational definitions as they apply to this study.

CAREER LADDER: A vertical arrangement of jobs within an occupational area to indicate skill distinction and progression.

CATALOGS: A comprehensive collection of performance objectives, performance guides, criterion-referenced measures, and related data organized by a job structure or career ladder within a domain of interest.

CONSORTIUM: A group of state agencies, institutions, or other entities which has been legally constituted through letters of commitment, agreements, or by assignment of higher authorities to work together toward the solution of problems in education. A membership from autonomous agencies and institutions which cuts across state boundaries as it attempts to solve problems or meet goals.

D.O.T. CODE: A nine-digit number used to identify a specific job within a given domain.

INSTRUCTIONAL SYSTEM DEVELOPMENT (ISD): A deliberate, orderly process for planning and developing instructional programs which insures that personnel are taught the knowledge, skills, and attitudes essential for successful job performance. Depends on a description and analysis of the tasks necessary for performing the job, objectives, evaluation procedures to determine whether or not the objectives have been reached, and methods for revising the process based on empirical data.

OCCUPATIONAL INVENTORY (TASK INVENTORY BOOKLET): A survey instrument containing tasks performed by job incumbents within D.O.T.'s complete with background information and a list of tools and equipment.

PERFORMANCE-BASED INSTRUCTION: Instruction which, when properly designed and applied, results in the learner's demonstration of certain abilities. The desired abilities are selected before the instruction is designed and are clearly defined as observable performance objectives. In V-TECS catalogs, the abilities are primarily psychomotor. This type of instruction is also referred to as competency-based instruction.

PERFORMANCE GUIDE (PG): A series of steps arranged in a sequence ordinarily followed, which when completed may result in the performance of a task. Also, called "teaching steps."

PROJECT: An occupational domain area selected by a V-TECS member state for catalog; development based upon the U.S. Department of Labor's Dictionary of Occupational Titles (D.O.T.).

STATE-OF-THE-ART (SOA STUDY): Research conducted to determine the current status of performance-based instructional materials and practices in the domain area under study and to obtain other information that might be useful in catalog development.

TASK: A unit of work activity which constitutes logical and necessary steps in the performance of a duty. A task has a definite beginning and ending point in its accomplishments and generally consists of two or more definite steps.

TASK ANALYSIS: A characteristic of a task statement which makes its accomplishments crucial to the acceptable performance of a worker or student. A method of analysis which identifies the critical tasks and aids in determining the consequence of poor performance or lack of performance by the worker or student.

WRITING TEAM: A team of people representing instructors within subject matter expertise, persons having knowledge and experience in developing criterion-referenced measures, and local or state supervisors of incumbent workers whose function is to analyze occupational data and develop performance objectives and criterion-reference measures for specific D.O.T. areas.

APPENDIX C

TOOLS AND EQUIPMENT

APPENDIX C

TOOLS AND EQUIPMENT

EQUIPMENT BY PERCENTAGE RATING

Equipment Number	Equipment Description	Percentage Using	Number Using
96	Tape, Steel	98.89	89
115	Wrenches, Adjustable	97.78	88
4	Blueprints	96.67	87
21	Drills, Power	96.67	87
24	Easy Cuts	95.56	86
69	Punches, Center	95.56	86
78	Screwdrivers	95.56	86
89	Straight Edge	95.56	86
114	Wrenches, Box	95.56	86
22	Files	94.44	85
37	Grinder, Bench	94.44	85
38	Hacksaw	94.44	85
51	Maintenance Manuals	94.44	85
104	Vises	94.44	85
113	Wrenches, Allen	94.44	85
18	Drawings	93.33	84
61	Pliers	93.33	84
65	Prybars	93.33	84
11	Chisels	92.22	83
12	Clamps and Straps	92.22	83
20	Drills, Hand	92.22	83
36	Grinder, Hand	92.22	83
49	Level	92.22	83
80	Sidecutters	92.22	83
70	Reamers	91.11	82
86	Square, Combination	91.11	82
16	Crowbar	90.00	81
46	Jacks, Hydraulic	90.00	81
60	Parts Manual	90.00	81
66	Pullers, Bearing	90.00	81
67	Pullers, Gear	90.00	81
79	Scribes	90.00	81
9	Calipers, Outside	88.89	80
26	Gage, Feeler	87.78	79
41	Holding Device, Mechanical	87.78	79
116	Wrenches, Impact	87.78	79
19	Drill, Center	86.67	78
85	Specification Manuals	86.67	78
111	Wirecutters	86.67	78
8	Calipers, Inside	85.56	77
68	Pullers, Wheel	85.56	77
81	Sketches	84.44	76
47	Jacks, Screw	83.33	75

Equipment Number	Equipment Description	Percentage Using	Number Using
84	Specifications Charts	83.33	75
112	Work Orders	83.33	75
97	Technical Manuals	81.11	73
39	Hammer, Chipping	80.00	72
117	Wrenches, Snap on Box	80.00	72
31	Gage, Thread	78.89	71
52	Mauls	78.89	71
48	Jigs	77.78	70
62	Plumb Bob	77.78	70
55	Micrometer, External	75.56	68
25	Gage, Depth	74.44	67
43	Indicator, Dial	74.44	67
76	Scale, Machinist	74.44	67
17	Dividers	73.33	66
72	Requisitions	72.22	65
75	Scale, Flexible	70.00	63
77	Schematics	68.89	62
107	Welder, Arc	68.89	62
7	Calipers, Dial	67.78	61
10	Calipers, Vernier	67.78	61
50	Magnifying Glass	67.78	61
95	Tachometer	67.78	61
40	Holding Device, Magnetic	66.67	60
54	Micrometer, Depth	66.67	60
57	Micrometer, Internal	65.56	60
101	Torch, Blow	64.44	58
5	Brush, Paint	63.33	57
23	Formulas	63.33	57
74	Sander, Power	63.33	57
108	Welder, Gas	62.22	56
64	Protractor, Bevel	61.11	55
82	Soldering Guns	61.11	55
103	Verniers	61.11	55
6	Buffer, Hand	60.00	54
27	Gage, Height	60.00	54
100	Thermometer	58.89	53
32	Gage, Wire	55.56	50
83	Soldering Irons	55.56	50
28	Gage, Radius	53.33	48
94	Tables, Mathematical	53.33	48
91	Strippers, Wire	52.22	47
2	Angle Plate	48.89	44
93	Stud Drivers	47.78	43
13	Clippers	45.56	41
88	Square, Master	45.56	41
30	Gage, Template	42.22	38
63	Polisher, Power	42.22	38
87	Square, Indicator	42.22	38
29	Gage, Surface	41.11	37
45	Inspection Orders	40.00	36
1	Ammeter	38.89	35

Equipment Number	Equipment Description	Percentage Using	Number Using
45	Inspection Orders	40.00	36
1	Ammeter	38.89	35
105	Voltmeter	36.67	33
106	Volt-Ohm-Milliammeter	35.56	32
35	Graphs	32.22	29
73	Riveting Guns, Power	32.22	29
3	Approval Slips	31.11	28
102	Transit	31.11	28
58	Micrometer, Thread	30.00	27
110	Welder, Tig	30.00	27
99	Test Sheets	28.89	26
56	Micrometer, Flange	22.22	20
42	Holding Device, Vacuum	21.11	19
59	Micrometer Tubing	21.11	19
109	Welder, Mig	20.00	18
44	Impedance Measuring Equipment	18.99	17
90	Stress, Strain Recorders	13.33	12
92	Stroboscope	13.33	12
71	Rejection Slips	12.22	11
15	Conductometer	11.11	10
98	Tensiometer	11.11	10
33	Galvanometer	7.78	7
53	Meter, Frequency	7.78	7
34	Goniometer	6.67	6
14	Colorimeter	5.56	5
		TOTAL RESPONDENTS	90

APPENDIX D

HAND TOOLS AND SAFETY EQUIPMENT

APPENDIX D

HAND TOOLS AND SAFETY EQUIPMENT

Maintenance Mechanic's Tool Box (Hand Tools)

Calipers, hermaphrodite
Calipers, inside
Calipers, outside
Calipers, vernier
Chisels, assorted, steel cold
Dial indicators
Feeler gauges (set)
Files, assorted
Flashlight, safety, 2 cell
Hacksaw
Hammer, ball peen
Hammer, chipping
Mallet, rubber
Micrometer, external 1"
Micrometer, internal
Micrometer, depth
Pliers, needlenose
Pliers, regular
Pliers, side cutter
Punches, canter, set of 4
Punches, pin, set of 4
Safety locking block
Scale, 6" steel
Screwdrivers, assorted, flat
Screwdrivers, phillips, assorted
Screw extractor set
Scribes
Shim Stock, assorted
Straightedge 1.4" x 1" x 24"
Spirit level
Square, combination
Tags, safety
Tape, 10 foot steel measuring
Vise grips
Wrenches, allen, assorted
Wrenches, hex box/open end, 1/4"-1"
Wrenches, adjustable, 6"-12"
Wrenches, pipe, 6"-12"
Wrenches, socket, 3/8" drive
Wrenches, socket, 1/2" drive

Maintenance Mechanic's Personal Safety Equipment (PSE)

Safety glasses
Safety toe shoes
Hard hat
Gloves

APPENDIX E

SOURCES FOR STANDARDS

APPENDIX E

SOURCES OF STANDARDS

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APPENDIX F

STATE-OF-THE-ART LITERATURE

APPENDIX F

STATE-OF-THE-ART LITERATURE

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APPENDIX H

INFORMATION SHEET

COUNTERBORING, COUNTERSINKING & SPOT-FACING

INFORMATION SHEET

COUNTERBORING, COUNTERSINKING & SPOT-FACING

Counterboring is used to enlarge a hole to a given depth for a cap screw or bolt head. The tool is similar to an end mill with the addition of a PILOT. The PILOT is a plug slightly smaller than the hole you wish to counterbore. PILOTS are interchangeable and can be swapped as necessary from cutter to cutter. Pilots can be made of scrap material when one of the right size cannot be found. Normally this will be .001 or less. Because of the large surface area the tool should be run slower than the drill.

Spot-facing is very similar to counterboring. The tool used is the same. (Counterbore/w pilot). The primary use of this technique is to provide a flat surface for a bolt to seat against. It is used a lot with castings and rough forgings; also used on round surfaces. The main difference is that a spot-face is only deep enough to provide a 95 percent flat surface for the bolt/washer to seat against, usually not more than 1/32 inches deep.

Countersinking is for the purpose of enlarging the end of a hole to accept a flat head screw or bolt. Countersinking can also be used to deburr the edge of any hole. It leaves a slightly beveled edge which looks nice and won't cut.

Typical steps when counterboring, countersinking or spot-facing.

1. Lay out center punch or otherwise locate the hole location.
2. Carefully align the spindle of the machine on the exact center of the hole.
3. Clamp the workpiece securely to the table or clamp in vise or other fixture.
4. Center drill, drill, and if necessary ream the hole to size.
5. Being careful not to move the workpiece, remove the cutter from the drill chuck and insert the counterbore with a proper pilot attached.
6. Carefully bring the tool down until the cutting face of the tool just touches the work piece.
7. Lock the spindle in this position and, using the depth stop on the drill press, set the depth of the counterbore.
8. Turn the machine on and carefully begin to cut the counterbore being sure not to force the cutter.
9. Continue down to the stop. Let machine rest on the stop for a few moments before pulling out of the cut. This will give a nice flat finish in the bottom of the counterbore.
10. Turn off the machine and remove the counterbore.
11. Clean the chips off the workpiece and measure the depth to be sure it is correct. If it is not, reset the stop and recut the workpiece.
12. Deburr and clean off oil and grease to complete.

APPENDIX I

INFORMATION SHEETS

DRILLING, REAMING, AND HONING

INFORMATION SHEET

DRILLING, REAMING, AND HONING

Drilling, reaming and honing are all related to producing round accurately sized holes. Since the steps in performing each of these operations are the same, this instruction sheet can be used for any of these operations.

Drilling is the process of making a round, accurately sized hole in a specific location in or through a workpiece. Drills come in an assortment of sizing systems (fractional, numeric, alphabetic, and metric). There are many different types of drills, each designed to do a specific type of drilling. Some of the special types are: Center drills, core drills, pac-drills, spade drills, pivot drills, as well as the conventional types.

Reaming is the process of sizing a hole to an exact diameter. This is necessary where smoother, more accurate holes are required. Reaming can be performed either with a machine or by hand. Reamers come in two types. Type one are ground to a specific diameter (usually a standard size numeric, alphabetic, fraction or metric). Type two are adjustable and ground to reference size, then adjusted by the user to the size needed.

Honing is the process of even more accurately sizing a hole to an extremely exact diameter, where extreme smoothness, size accuracy and straightness are required, (as in a bearing inner race or bearing sleeve).

The standard procedures to be followed when drilling, reaming or honing are as follows:

1. Paint the workpiece with layout dye. Refer to the sketch or blueprint and carefully lay out or otherwise locate the position of the hole or holes.
2. Carefully mark the location of each hole with a centerpunch. Use a set of dividers and draw a proof circle at each location for reference.
3. Mount the workpiece in a drill press or other suitable machine for drilling.
4. Carefully align the center of the spindle with the center location of the hole.
5. Mount a center drill in the drill chuck on the machine, turn on the power and just spot the hole location with the point of the drill. (Do not drill any hole just yet). Check the location by measuring to the place just spotted or looking at the proof circle.
6. Once satisfied that the hole is correctly located, center drill the hole. At this point you should check again to see whether you need to ream or hone this hole. If so, select a drill which is slightly UNDERSIZED. Mount the proper drill and drill the hole to correct depth or drill through as required.
7. If the hole does not need any further finishing at this point you may remove the workpiece from the machine, deburr the edges of the hole and go on to the next operation required to complete the job.
8. If the hole is to be reamed or honed, refer to the following steps as a continuation of the hole drilling operation.
9. If you are going to ream or hone a hole after drilling, do not remove workpiece from the machine after drilling. Remove the drill from the chuck and prepare to ream or hone.

10. If the hole already exists, follow the set of procedures outlined earlier. (Be sure the hole is centered with the centerline of the spindle).
11. Select the correct size reamer or hone for the finished size of the hole and mount in the spindle of the machine.

Reaming:

12. SLOW the speed down!!!
13. Using PLENTY of cutting oil, run the reamer through the hole slowly and back out, ONCE only.
14. This completes the reaming process. The workpiece may now be removed from the machine and deburred.

Honing:

NOTE: Honing can be done using two different kinds of tools.

TYPE 1: The commercially available honing tool which consists of a frame with one or two stones and wipers. The diameter of this device can be adjusted as the hole size is increased thus providing an easy way to size holes which also require a smooth, straight finish.

TYPE 2: The shop made tool which consists of a turned plug made of aluminum or brass or other material soft enough so that an abrasive material (such as fine lapping compound) can be pressed into the surface of the hone.

15. Use the same speed or slightly faster for honing.
16. Select a proper sized hone or custom make your own from aluminum or brass. Mount in machine chuck.
17. Apply a quantity of lapping compound to the hone and slowly push the rotating tool through the hole. Back up and push through again. Do this several times and then stop. Remove the tool and clean the workpiece, check the hole for size, and finish. If now correct you may remove the workpiece from the machine and deburr. If not correct, replace the tool, add more compound, continue honing until size and finish are correct.
18. Remove workpiece from the machine and deburr. Move on to the next operation.

APPENDIX J

INFORMATION SHEETS

TAPPING

INFORMATION SHEET

TAPPING

Tapping is the process of cutting threads in a hole.

This procedure is most commonly performed as bench work by hand. However, when there are a great many holes to be tapped or workpiece cannot be removed from the machine, it is sometimes better to let the machine provide the power for driving the tap, or at least provide a support for the tap while the operation is turning the tap by hand. We will discuss both methods here.

1a. Carefully lay out the hole location(s) on the workpiece, center punch and scribe a reference circle at each location.
2. Set up drill press, align center punch with center spindle, clamp workpiece.
3. Refer to tapping charts and select the proper tap drill. (A drill selected to leave sufficient material in the hole to produce a 75 percent or greater full thread).
4. Spot with center drill and check to assure proper alignment.
5. Mount the tap drill and drill the hole to proper depth or through as required.

From this point, refer to the section which describes the operation you wish to perform.

By hand on the bench:

6. Remove from drill press and deburr the hole.
7. Using a proper sized "T" handle tap wrench or adjustable tap wrench, turn the tap into the hole by hand. Back off every 1/2 turn or so to break chips as you go.
8. Continue until tap has passed through the piece or has reached the proper depth. You may have to back out more than once to remove the chips in case of a blind hole.
9. Check thread for size and class of fit using the screw or bolt to be used in that hole or a thread gage. (A precision ground screw designed to accurately check fit and size of threaded holes).
10. Dig the chips out of the hole or use the air hose to clear the chips and deburr. Clean off oil and grease to complete.

By hand, on the drill press or other machine: (b)

1b. After drilling the proper sized tap drilled hole do NOT remove the workpiece from the machine. Leave the clamps in place.
2. Remove the drill from the chuck and insert a tool called a tapping center. (A ground pointed tool used to support the end of the tap while it is turned by the mechanic. It may be a solid piece or it may be spring loaded or both).
3. Engage the point of the center either with the tap or the "T" handled tap wrench for support.
4. Keeping pressure on the center, slowly turn the tap into the piece 1/2 turn. Release pressure and back off slightly to break the chip. Continue this procedure until tap cuts through the piece or until proper depth is reached. Remember the tap may have to be removed several times to remove chips from a blind hole.

5. Move on to next hole and repeat entire operation from step 1a.
6. Remove from the machine, deburr and clean all chips, grease and oil to complete.

By machine: (c)

1c. After drilling the proper size holes remove the drill and drill chuck.
2. Do not move your workpiece or remove any clamps.
3. In place of the drill chuck install a device called a tapping head. This is a special tool designed to drive a tap through a workpiece. It contains a set of gears to reverse the rotation of the tap and a slip clutch to disengage the drive should the tap become stuck. Another type of device is simply called a tap driver. This is a chuck designed to hold a tap. It has no provision for reversing or slip clutch.
4. Mount your tap in whatever device you are going to use to drive the tap.
5. SLOW down the spindle speed and start the spindle.
6. Press the tap into the hole firmly, using the quill on the machine. Keep the pressure on until tap cuts through the piece. If you are tapping a blind hole, set a stop or other device so that you know when to release pressure or stop the machine.
7. Reverse the machine and back the tap out. Clear all chips and check for proper fit and depth.
8. Move on to next hole and repeat from step 1a.
9. Remove from the machine, deburr and clean all grease and oil to complete.

   NOTE: It is not recommended that tapping by machine be attempted in blind holes without the proper type of tap driver and proper training and experience given to the machine operator. (Taps break easily and are expensive).

APPENDIX K

INFORMATION SHEET

CHANGING COOLANTS

INFORMATION SHEET

CHANGING COOLANTS

Most of the machines in a shop which are used for cutting metal, plastics, glass or other relatively hard material, with the exception of wood, use a coolant when cutting. A regular part of the maintenance of this equipment includes changing the coolant at regular intervals. Depending on usage, the rule is:

CHANGE THE COOLANT MONTHLY

Actually, coolants should be changed as often as necessary. Usage causes the lubricating qualities of the coolant to change, and it (the coolant) can become contaminated with the residue caused by the cutting action. If proper steps are not taken, coolants can also STINK!

The standard procedures to be followed are listed below. These rules hold for any machine using coolants.

1. Turn on power.
2. Using a pump in the machine, pump all coolant (all the pump will pick up) into a bucket, 55 gallon drum or into drain system. Check to see if all coolant has been removed from reservoir.
3. Flush coolant system with fresh water. Use a hose or add water with buckets until water comes out clear and clean.
4. TURN OFF ELECTRIC POWER, LOCK OUT, and TAG.
5. Clean reservoir tank. Scrape all residue from the tank and wipe clean if possible.
6. Check return systems. Clean inlets, check for leaks and broken or damaged hoses.
7. Refer to manufacturer's manual for the recommended coolant and coolant additives.
8. Mix proper amounts of coolant, additives and, if required, water.
9. Pour sufficient amount into reservoir to insure pump inlet is under surface.
10. Remove lock out and turn on power.
11. Using the system pump to provide circulation, pour remaining coolant mixture into reservoir and allow to cycle through the system.
12. Check for leaks or stoppage of flow through returns.
13. Clean floors of all spills.
14. Remove tag from power to complete.
    NOTE: An additive to prevent bacterial growth is recommended as well as a disinfectant. This will prevent strong, unpleasant odors.